EVALUATION OF GENETIC DIVERSITY IN FORAGE MAIZE *(ZEA MAYS L.)*

THESIS

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By :

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DECLARATION

I hereby declare that the thesis entitled **"Evaluation of genetic diversity in forage maize (*Zea mays* L.)"** being submitted for the degree of Doctor of Philosophy in Botany in Bundelkhand University, Jhansi (U.P.) is an original piece of research work done by me under the supervision of Dr. U. P. Singh, Principal Scientist (Economic Botany), Indian Grassland and Fodder Research Institute, Jhansi (U.P.) and the best of my knowledge and belief, is not substantially the same as one which has already been submitted for a degree of any other academic qualification at any other University or examining body in India or abroad.

Sanjeev Kumar
20/06/05

(Sanjeev Kumar Srivas)

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Sir,

I am forwarding herewith the thesis entitled **"Evaluation of genetic diversity in forage maize (*Zea mays* L.)"** by Mr. Sanjeev Kumar Srivas for the degree of **Doctor of Philosophy in Botany**, Bundelkhand University, Jhansi. The work has been carried out at Indian Grassland and Fodder Research Institute, Jhansi under the supervision of Dr. U.P. Singh.

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Contents

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Chapter - I

Introduction

INTRODUCTION

Maize (*Zea mays* L.) is one of the important economic grain crop as also an ideal cereal forage crop because of its quick growing, high yielding, palatable and nutritious qualities. It is used as fodder at various stage of plant growth, particularly from tasselling onward. The maize plant does not have problems of prussic acid or hydro cyanic acid and therefore it can be used as fodder even before flowering or even in dry weather. Maize with ears at the dough stage is best for use as fodder. It surpasses all other crops used as fodder in dry matter production and digestible nutrients per hectare. Stover left after the harvest of the grain is also used as fodder, particularly if stay- green type varieties are used where stalks and leaves are still green at harvest time.

About 40% of maize produced in many countries is used as animal feed. Maize gives the highest conversion ratio to meat, milk and eggs as compared to other grains used as livestock feed. Its high starch and low fiber content makes it a highly concentrated source of energy for livestock production. Precise statistics on the use of maize for various livestock and poultry feed are not available. However, it is believed a greater portion is used as poultry feed in tropical countries. Yellow maize is preferred for livestock feed. It is fed as whole grains, cracked or coarse ground, dry or wet or steamed and usually supplemented with other protein and vitamins sources. It is expected that the use of maize in formulated feed for poultry will increase rapidly in the future.

Quite often, maize is grown as a multi-purpose crop for food fodder and feed, and various parts of the plant are used as fodder. Maize grain is an important cereal for human consumption, particularly in Asian countries. There is no doubt that the demand for maize as feed will continue to increase in the future at a very fast rate. In this respect, as per the FAO reports the

demand for feed will increase from the present level of 105 mt to almost 400 mt in 2030, corresponding to a 295 mt increase (240%). It is a big challenge to produce these additional 295 mt that will be needed in 2030 for human consumption and animal feed.

Maize is the third most cultivated cereal after wheat and rice in the world. The maize is sown in almost all the states in the country and it occupied fourth position area wise (6.59 mha) next to rice, wheat and sorghum but third in production. Demand for maize is going up in India with the increase in demand for animal feed. At present about 35% of the maize produced in the country is used for human consumption, 25% each in poultry and cattle feed and 15% in food processing and other industries (mainly dextrose, corn syrup, corn oil etc.). The present production of maize in India is only 10.16 mt and the annual demand is going up by about 4 lakh tonnes. The average yield in India is only 1.7 t/ha against a world average of 3.83 t/ha.

Maize is widely adopted in different environments. It is cultivated in tropics, sub-tropics and the temperate region of both the northern and the southern hemisphere. Maize is grown at varying elevations, as high as 3800 m above sea level and performs amazingly well under varying photo-period, rainfall, temperature and soil condition (Vasal and Taba, 1988). Another important feature is that the crop can be grown successfully during summer where irrigation is available.

The stover (entire dry plant) of maize has a crude protein content of about 7% (on dry matter basis) and has relatively poor feeding value during the later stages of growth. On the other hand, the feeding value of developing cob increases rapidly. It consists largely of easily digestible carbohydrates together with a rather higher crude protein content and about half the crude fiber content of the stover. Thus, unlike most fodder crops, as the maize crop matures the increasing contribution made by the ears results in improved feeding value. Steinhofel (2000) reported that the highest fodder energy value was reached when the translocation of starch into the maize kernel was furnished, but the water content of the rest of the plant was still high.

With the increasing accent on animal production including poultry, the demand for maize is expected to increase substantially. Hence, considering the demand projection, there is an ample scope for local consumption

provided maize production is enhanced in the region. Maize for fodder is generally ensiled and it is perhaps the best crop for making silage. It can also be fed green or grazed. The stover of maize grown for grain can be used for dry season grazing. Harvesting for ensilage is done generally at the milk or dough-ripe stages of grain maturity, for this the whole plant is harvested and chopped either by machine or hand. Maize silage provides excellent fodder for fattening cattle and milk cows. It should be supplemented, however, in these cases with a high protein feed. Alternatively, the cobs may be harvested for commercial use and remaining plants can be grazed as green stover, and/or ensilaged.

Amongst the forage crops maize is known to be adaptive to a range of soil moisture regimes, day length and temperature. The genetic improvement in forage maize, however, could not make headway and the gap still remain to be filled up through development of improved forage varieties in this crop. Systematic information on the extent of genetic diversity in existing forage maize germplasm, behavior of forage yield components, classification and its consistency of performance over the environments is scanty or hardly available. The present study is expected to generate such information.

Origin of maize and its genetic relationship with other taxa

Maize (*Zea mays L.*) is widely grown throughout the world today. Wilkes and Goodman, (1996) characterize maize as having "a passport without a birth certificate" because its parentage is still shrouded in mystery. Maize has been in cultivation for several thousand years in Mexico as indicated by unearthed grains and parts of ears reported from caves and rock-shelters supported by archeological excavations in New Mexico (Berger, 1962). The oldest archaeological remains of maize, excavated in the valley of Tchuacan in southern Mexico, suddenly appeared in the archaeological records around 5000 B.C. (Flannery and MacNeish, 1997). Maize is said to be originated in Latin America, where maximum genetic diversity in *Zea* and their wild relatives exist (Margelsdorf, 1974; Hallauer and Miranda, 1981). It was the only cereal systematically cultivated by the Red Indians although some other grains were harvested from the wild. Columbus found corn being

cultivated in Haiti, where it was called *Mahiz* and from this Indian word, the name 'maize' was derived that is used in Europe to distinguish the cereal from other grains, which are called corn.

Based on several studies (isozyme pattern), least genetic distance was observed between maize and teosinte . The hierarchical order of Maydeae is maize > teosinte > coix > triolobanche > chionachne (Sachan and Singh, 2001). Distribution of C and Q bands in constitutive heterochromatin in maize and teosinte were terminal as well as sub-terminal and comparable to each other. Chromosome banding patterns of maize and teosinte showed reciprocal introgression of c-heterochromatin. Palynological study based on pollen exine surface indicates similarity among three species of *Teosinte* and *Zea*. Based on chiasma frequency following relationship has been deduced *Z. diploperennis* > *Z. luxurians* > *Z. parviglumis* > *Z. mays* (Sachan and Singh, 2001).

Taxonomy

Maize (*Zea mays* L.) belongs to the grass family, Poaceae (syn. Gramineae), subfamily, Panicoideae, which includes the majority of grasses in tropical and sub-tropical regions throughout the world. Whereas most grasses have perfect flowers, maize and its wild relatives, *Teosinte* and *Tripsacum*, are monoecious, i.e. they have separate staminate and pistillate flowers on the same plant, and this was the reason maize and its relatives were once grouped into a separate taxonomic tribe the *Maydeae* (syn. *Tripsaceae*). Stebbins and Crampton (1961) revised this classification and placed *Zea* and *Tripsacum* in the *Andropogoneae.* Other members of the *Andropogoneae* endemic to the New World are mainly *Coix, Trilobachne, Polytoca, Schleracne, Chionacne,* as well as the important economic grasses sugar cane and sorghum (Kellogg, 1998).

A maize plant is a tall, leafy structure with a fibrous root system, supporting usually a single main culm with many leaves. One or sometimes two lateral branches in the leaf axils in the upper part of the plant develop more prominently. These are terminated by a female inflorescence, which develop into an ear (cob) well covered by husk leaves. This is the food

storage part of the plant. The plant is terminated by a male inflorescence, the tassel. It has a prominent central spike and several lateral branches with male flowers, all of which produce abundant pollen grains. Maize is a monoecious plant. It develops inflorescence with unisexual flowers that are always borne in separate parts of the plant. Maize is one of the few food plants that is diploid with a basic set of ten chromosome or 2n= 20.

Genetic variability and adaptability of maize

Genetic diversity has played an immense role in evolution and domestication of any crop. Genetic variability constitutes the invaluable asset to meet the growing need to increase the production and productivity. Enormous diversity occurs in India for maize. The richness of this diversity is more in the tribal dominated areas where subsistence farming is being practiced. Area such as Himalayan region, northeastern part and peninsular India is rich in genetic diversity for maize and ethnic communities here are custodians of genetic resources. A wide array of maize germplasm occurs in India particularly in Northeastern Himalayan region, Himachal Pradesh and Jammu & Kashmir.

Although maize is reported to have originated in Latin America, it has attained widespread geographical distribution. This might be due to gradual evolution of new genotypes because of its cross-pollinated nature. The free intercrossing among genotypes has produced a wide diversity of genetic recombinants. Though natural selection thereof may have become adapted to the new agro-ecological niches through a gradual process of acclimatization. Maize is also known to have many races, the natural hybridization between these races as well as contribution of traits from near relatives such as *Teosinte, Tripsacum, Coix* etc. may have contributed significantly to the present array of genetic diversity in maize.

India is considered as secondary center of origin for maize. Substantial genetic diversity occurs in accessions collected from different agro-climatic zones. Gradual natural as well as selective hybridization and introduction of exotic germplasm has considerably enriched the genetic diversity of maize. This is the reason of wide adaptation of maize ranging from arid-climate of

Rajasthan to humid tropics of Northeastern India and also from mid sea level zone to higher altitude of Himalayan, Aravali and Nilgiri hills.

Preliminary work done on the line

Most of the research work has been carried out in India and abroad on the grains aspect of maize crop. Hence, no attempts have been made so far in India for classifying genetic materials of forage maize. Although maize is being used since a long time as a dual-purpose crop, however, forage based collection, evaluation and documentation of maize germplasm has not been done as yet. It was felt that there is need to make a systematic attempt for collection, assessment land categorization.

At IGFRI, Jhansi efforts have been made to collect the available genetic diversity from different eco-geographical parts of the country through a series of exploration programmes. It was in this context that 1571 local maize cultivars were collected under a scheme in 1969 sponsored and financed by the ICAR. The entire collection was classified into 15 races and 3 sub-races ranging from primitive to advanced types. The genetic diversity is being maintained at IGFRI as well as at National Gene Bank, NBPGR, New Delhi

Collection and evaluation of available wide gene pool of forage maize is very important for developing suitable cultivars. It is imperative to have a clear cut idea about the correlation of different characters and their contribution to green and dry forage yield for its further genetic improvement programme.

Keeping in view, importance of the crop and the meager availability of genetic information pertaining to the genetic diversity, association and phenotypic stability in forage maize, the present investigation was conducted with the following objectives:

- To study the extent of variability present in the available germplasm for yield and yield contributing characters and their relative importance.

- To measure genetic divergence between strains of the different geographical origin.

- To study the relationship between yield and yield contributing traits, the relationship among themselves and their direct and indirect effects on yield.

- To identify the differential response of various accessions over different environments and to find out stable accessions.

Chapter - II
Review of Literature

REVIEW OF LITERATURE

Maize (*Zea mays* L.) is one of the most important economic crop plant and is almost an ideal cereal forage crop because of quick growing with high yielding potential and nutritious with high palatability. It is a widely distributed cereal crop throughout the world with many uses. It is much exploited cereal crop in the world mainly as food crop but it is also very important forage crop. The selection of maize hybrid for forage production in many countries, including major maize growing region in India has generally been based on their grain production potential. The mode of utilization of maize as fodder may vary from its use as green fodder, hay or silage. The main objective of any forage production programme is to provide high nutritious fodder in accordance with the feed requirement of animals. The maize plant forms excellent forage for cattle with above average dry matter yield and digestible nutrients per hectare (Perry, 1988).

Very little attention has been given to the improvement of maize as a fodder crop. Some research results are available that could be useful in improving maize as forage crop. However, limited work has been done on this aspect. Keeping this in view, efforts have been made to review the information available on this species pertaining to different aspect like genetic variation, genetic divergence, association and stability aspect vis-à-vis genotype x environment interaction of the accessions for yield and yield contributing characters as well as quality characters. The information available on these aspects on maize is reviewed under the following sections:

2.1 Genetic variability

2.2 Genetic divergence

2.3 Character association and path- coefficient analysis

2.4 Gene x Environment interaction and phenotypic stability

2.1 Studies on genetic variability

Genetic diversity is an essential requirement for any crop improvement programme, because genetically diverse parents when crossed can bring together gene combinations, which can be exploited to obtain superior recombinants. Genetic improvement mainly depends upon the amount of genetic variability present in a population. In any crop, germplasm serves as valuable source of base population and provides scope for wide variability. Information on the nature and degree of genetic divergence would help the plant breeder in selecting the right type of parents for breeding programme. Vavilov (1951) was first to indicate the importance of greater range of variation in material for rapid improvement.

Availability of genetic variability for the component characters is a major asset for initiating a fruitful crop improvement programme. Plant breeding has amply been defined as a purposeful management of variability. Since whole breeding pursuit relates to the creation and management of genetic variability, the proper information on this aspect is a pre-requisite before embarking on any breeding method. Finlay (1971) has stressed the importance of continuous infusion of new genetic variability in active plant breeding programmes.

Singh and Sharma (1970) reported that the genetic variability estimates were high for yield per plant, number of days to 75% silking, plant height and position of cob in maize.

Gouesnard *et al.* (1989) found genetic variance in intra and inter population hybrids was the same, dominance variance was significant for yield and cob leaf length, whereas additive variance explained most of the genetic variability in earliness of flowering, plant and cob height, cob width and dry matter content. Additive variance was similar for highly heritable traits but that for yield was markedly different.

Alika (1994) studied genetic variability among S_1 families for ogi yield in maize and found ogi yield ranged from 33.9 to 56.5% with mean of 49%. The 100 grain weight ranged from 19.1 to 35.5 g with a mean of 26.7 g.

Bertoia *et al.* (1995) subjected commercial maize hybrids normally grown for grain to principal component analysis for forage traits over three years. Plant height,

stover digestibility were the traits with the greatest discriminatory values in the first component, which explains 46.25% of total variation.

The inheritance of grain yield, cob diameter, cob length, number of grain rows and 100 grain weight was studied by Turgut *et al.* (1995). Both dominance and additive effects appeared significant for all the traits, but the dominance component of genetic variance was more important for all traits except 100- grain weight. Dominance effects in the direction of high grain yield, but was not unidirectional for components of yield. Dominance was complete for all traits except number of grain rows.

Betran and Hallouer (1996) found additive genetic variance component was the most important component of genetic variability for all traits. Except for grain yield, additive by environment interpopulation variance estimates were smaller than their corresponding additive variance. For grain yield, the additive variance component increased with selection; however, the original population cross-showed greater additive by environment interaction variance than the improved population crosses. The estimates of additive genetic variance increased for plant and cob height with recurrent selection for yield. Except for grain yield all traits exhibited a decrease in estimates of the dominance variance component after selection.

Chen Ling *et al.* (1996) found that additive gene effects were more important for cob thickness and kernel rows/cob. Inheritance of cob length, 100 grain weight and dominant effects controlled grain yield/plant. For cob thickness, recessive genes had positive effects and dominant genes had negative effects.

Mani and Bisht (1996) studied genetic variability in local maize of U. P. hills and found that genotypic coefficient of variation was having moderate to high genetic variability for the majority of characters, except cob girth, number of rows/cob and shelling percentage, that showed low variability. The genetic variability in the local germplasm for the desired traits, *viz*, grain yield, maturity, cob length and 100 grain weight will be of greatest value, for breeding highly adapted early maturing composites and hybrids of maize for the UP hills.

Katiyar *et al.* (2001) studied variability pattern in collected genetic material of maize for various cob and kernel attributes. Wide variation occurred in cob length

(6.4- 24.0 cm). About 5% accessions had cob length between 22- 25 cm whereas the highest number of accessions (84) was observed in class interval 14.0- 17.90 cm. The cob diameter ranged from 2.20 to 4.90 cm although majority of accessions had cob diameter varied from 3.48 to 4.12 cm. Kernel number per row also depicted unimodel asymmetrical distribution. Extreme high as well as low classes of kernel number/row was observed in about 8 and 6% accessions respectively. So far as kernel colour is concerned it showed wide variability as: 118 accessions (53%) had yellow kernel, 69 accessions (31.22%) white, 11 accessions (4.98) purple, 9 accessions (4.07%) variegated and 14 accessions (6.34%) had brown colour.

2.1.1 Heritability and genetic advance

With the help of genotypic coefficient of variation alone, it is not possible to determine the amount of heritable variation. Heritability estimate (in broad sense) is a reliable parameter for evaluating the genetic potential of a given population. Wright (1923) put forth the concept of heritability in pure lines as additive genetic variance expressed as percentage of the total variance. Lush (1949) defined heritability in broad sense, as the ratio of total heritable variance to the total phenotypic variance. He further suggested that heritability in narrow sense includes only average effects of a gene transmitted from parents to the progeny or the ratio of the additive variance to the total variance.

Heritable variation can be found out with greater degree of accuracy when heritability in conjunction with genetic advance is studied (Dudley and Moll, 1969). Hence, both heritability and genetic advance were determined to get a clear picture of the scope of improvement in various characters through selection.

Sviridov (1979) calculated the coefficients of heritability for plant height, number of grain rows per cob and cob length taking into account the close correlation between number of grains/ cob and cob length and also between number of leaves/ plant and plant height. Heritability estimates were greater for number of grain rows per cob (60) and plant height (59.9) in which the latter character showed over dominance. Cob length gave the lowest heritability estimates (31.1).

Kumar (1982) reported high coefficient of variation and estimates of heritability and genetic advance were found for leaf weight, cob weight and forage yield/plant.

Gallais *et al.* (1983) studied heritability in maize and reported heritability estimates were high for morphological characters and earliness and low for dry matter yield.

Claudio *et al.* (1988) found high narrow sense heritability estimates for plant height and cob length and low for leaves/ plant and grain yield/plant whereas, cobs/plant had the lowest heritability.

El-Harary (1989) reported moderate to high heritability estimates for all components, ranging from 23.5 (rows/cob) to 67.1 (grain/row) in a synthetic variety of maize.

High heritability estimates and substantial expected genetic advance were found for leaf area and 1000- grain weight. Singh *et al.* (1989)

Arha *et al.* (1990) in their studies on heritability and expected genetic advance in maize observed heritability was highest for days to silking; moderate values were recorded for plant and cob height, number of leaves above the cob and cob length.

Progenies from S_1 families derived from a maize population introgressed by *Zea diploperennis* were evaluated in 1988-89 (Pischedd and Magaga, 1990). Heritability estimates ranged from 27% for plant height to 63% for 50 grain weight. Heritability of prolificacy was high (61%) but that of yield (cob weight/ plant) was low (33%).

Alika (1994) found broad sense heritability estimates to be 55.4 and 52% for yield and 100 grain weight respectively. The value for predicted genetic advance from 30% selection for ogi yield and 100 grain weight averaged 6.1 and 7.2% respectively, while the actual genetic advance averaged 9.6 and 13.6% respectively.

Satyanarayna and Saikumar (1995) observed wide and significant phenotypic variation for grain yield and other characters in maize. Grain yield recorded low genotypic coefficient of variation estimates combined with low to medium heritability and low genetic advance. This indicated the probable predominant role of non-additive gene action governing the inheritance of grain yield.

Betran and Hallouer (1996) found that heritability estimates for grain yield increased with recurrent selection. Heritability estimates of the original and selected cross population were similar for the other traits.

Chen Ling *et al.* (1996) estimated heritability for cob length, cob thickness and kernel rows/cob, which ranged from 50.8 to 87.9% and was higher than those for 100 grain weight and grain yield/plant.

Mani and Bisht (1996) made a study on genetic variability in maize germplasm of Uttar Pradesh and observed high heritability (Broad sense) along with high genetic advance for days to 50% silking, grain yield, total number of leaves, cob height and moisture percentage in grain at harvest. For plant height these values were moderate, while they were low for the rest of the characters.

Satyanarayna and Saikumar (1996) found differences between the genotypes with respect to grain yield and number of days to 50% tessaling. Heritability and phenotypic and genotypic variance estimates were high for yield, suggesting this character may be improved by recurrent selection. Whereas, Ortiz and Sevilla (1997) reported highest heritability and coefficient of variation for cob length, rows of kernels, cob diameter and kernel width.

Tusuz and Balabanli (1997) studied heritability of main characters affecting yield and determination of relationships among these characters. Over two years of the experiment, heritability in the broad sense was highest for 50% silking (0.93) and low for plant height (0.12), cob length (0.31) and for yield (0.06). Yield was significantly correlated with 50% silking days ($r = 0.67$), plant height ($r = 0.50$) and cob length ($r = 0.42$). The yield potential of all varieties changed from year to year and a significant environmental effect was observed.

2.1.2 Studies on quality parameters

Maize is grown over a wide range of environments and geographical areas than any other cereal crop, with its multifold use for human, livestock feeding and industry. The residual stover after removal of cobs is important roughage for ruminants in tropical countries. Nutritionally, maize stover has higher crude protein and lower cell wall content and silica than sorghum and pearl millet stover (Sen and

Roy, 1971). Cell wall constituents of a plant are very important factor, which affect the forage intake and digestibility (Von Soest, 1965). Sugar contents, leaf–stem ratio and their proportionate thickness have a significant effect on forage yield and its nutritional quality.

Crude protein content, cell wall constituent's concentration and dry matter degradability are the potential criteria for screening the diverse genetic material at initial stage of forage breeding programme from the livestock feeding point of view. The main objective of any forage production programme is to provide nutritious fodder in accordance with the feed requirement of animal (Hulton, 1975).

Roth *et al.* (1970) studied the genetic variation of quality traits in maize and found that genetic variability was apparent for *in vitro* digestible dry matter constituents and crude protein. All the characters except crude protein content were found inter co-related.

Laredo and Minson (1973) reported higher crude protein and lower NDF(Neutral detergent fiber), ADF(Acid detergent fiber) and lignin contents in leaf and stem fractions of grasses.

Fairey (1980) evaluated 97 hybrids differing in maturity and genetic constitution in three dissimilar environments and reported that forage yield was linearly related to grain yield at each site and the relationship was distinct for each site. However, grain yield was not a good indicator of forage productivity. At each site, forage dry matter content depended on the dry matter of the Stover and the proportion of total dry matter as grain or in the cob.

Singh and Katiyar (1999) studied fodder yield and nutritional variability in leaf and stem of seven maize genotypes and found crude protein value ranged from 10.32 to 12.92 in leaves and 3.49 to 6.69% in stem fraction, respectively.

Information is needed on the factors that maximize yield and quality of recently developed maize forage hybrids. A study was conducted by Widdicombe and Thelen (2002) to determine the effect of row width and plant density on forage yield and quality of forage maize hybrids and dual-purpose hybrids. They found that when row width was reduced, forage dry matter increased. As plant density

increases from the lowest level to the highest, forage dry matter increased by 1.6 t/ha^{-1} and crude protein decreased from 76 to 72 g/kg^{-1}.

Sananta et al. (2003) studied silage quality of different forages reported dry matter of the forage ranged from 28.60 to 31.52%. Water-soluble carbohydrate content was highest (6.12%) in fodder sorghum while it was lower in natural grasses (1.51%). Similarly, the CP content was also lowest (3.68%) in natural grasses and relatively more in maize and fodder sorghum (6.58%).

2.2 Genetic divergence

The importance of genetic divergence for improving yield potential, *per se* through hybridization has been emphasized by several authors and reviewed by Frey (1971). Although, breeders have long appreciated it, the basic difficulty has always been one of recognizing such diversity and its reliable estimation without making actual crosses (Bhatt, 1970). Since most of the quantitative characters are highly influenced by environments, it becomes difficult to separate non-heritable components from heritable components of variability based on phenotype.

In the past, geographical distance of species and varieties has often been considered as a criterion for the measures of genetic diversity (Dhawan and Singh, 1961; Moll *et al.*, 1962; Singh and Joshi, 1966) but the criterion was overruled by Somayajula *et al.* (1970), Jayaprakash *et al.* (1974) and Chandra (1977). Therefore, a technique, which can provide direct and reliable estimates of diversity at genetic level, will obviously be more useful. Hutchinson's polygraph (Hutchinson, 1936) and metroglyph and index score analysis (Anderson, 1957) broadly classified the germplasm but they did not provide numerical estimates for precise comparison.

To discriminate the function, Fisher (1936) suggested the useful criterion to select the best individuals from populations based on single parameter. However, the situation becomes difficult when the number of variables to be considered is increased. Pearson (1926) suggested the coefficient of racial likeness (CRL) as a single numerical measure, which would express the degree of resemblance or divergence of two races when several characters were measured on relatively few

individuals from either or both the races. Rao (1948) pointed out that CRL was an imperfect tool because it neglects correlations between characters under study.

Mahalanobis (1925) gave the concept of generalized distance based on second-degree statistics and it is self-weighing on the basis of genetic variability. Mahalanobis (1928) suggested that CRL was a 'test' of divergence between two samples rather than an actual measure of magnitude of genetic divergence and it would be logical to use measure and not the test of divergence for quantitative comparisons between the populations. Mahalanobis (1930) for the first time applied his D^2 statistics on the extensive measurement of Swedish (human) population. In anthropological survey of united province this technique was further applied (Mahalanobis, 1949).

Genetic improvement mainly depends upon the amount of genetic variability present in a population. In any crop, germplasm serves as a valuable source of base population and provides scope for wide variability. Information on the nature and degree of divergence would help the plant breeder in choosing the right type of parents for breeding programme (Vivekanandan and Subramanian, 1993). Hence estimation of genetic diversity for fodder and grain yield as well as other traits among accessions is important for planning the future crossing programmes. Characterization of genetic divergence for selection of suitable and diverse accessions should be based on sound statistical procedures, such as D^2 statistic (Mahalanobis, 1936) and non- hierarchical Euclidean cluster analysis (Beale, 1969; Spark, 1973). These potent tools for estimation of divergence have been emphasized by many workers (Murty and Arunachalam, 1966; Anand and Murty, 1968 and Arunachalam, 1981).

In maize it is well known that genetic diversity is necessary in breeding programme for development of high yielding varieties. Multivariate analysis is a useful tool for quantifying the degree of divergence between biological population at genotypical level and assessing relative contribution of different components to the total divergence at both intra and inter cluster level (Ram and Panwar, 1970 and Sachan and Sharma, 1971).

Endang et al. (1971) stated that clustering pattern could be utilized in choosing parents for cross combination, which likely to be generate the highest possible variability for the effective selection of various economic traits.

Little attempt has been made to classify genetic diversity in maize however, some efforts have been initiated and 1571 maize accessions collected from the important maize growing areas of India (Singh, 1969). This study leads to the recognition of 15 distinct races and 3 sub-races. These races were further grouped into primitive, advanced or derived, recent introduction and hybrid races, all of which could be easily assigned to three of the six lineages postulated by Mangelsdorf (1974).

Cruz *et al.* (1994) quantified genetic divergence among five maize varieties for eight yield- related traits and values obtained were used to evaluate the efficiency of predicting the performance of corresponding hybrids.

Cruz *et al.* (1994a) again estimated genetic divergence among five maize varieties for seven yield related traits by four different methods. Mahalanobis generalized distance and the average Euclidean distance based on standardized variables, on the scores of the first two canonical variables and on first two principal components representing more than 94% of the total variance). Coefficient of correlation estimated at higher than 0.93 between the measures of divergence showed a high degree of agreement between the methods.

Katiyar *et al.* (2000) used non-hierarchical Euclidean cluster analysis to compare the maize genotypes. Accessions were classified into 12 broad groups. Group E was the largest, consisting of 35 accessions, while minimum number (18 accessions) were observed in cluster J. There was no correlation between genetic and geographical diversity.

Lakshmi Kant *et al.* (2001) used non-hierarchical Euclidean cluster analysis for different traits of wheat germplasm. The accessions were grouped into eight clusters. Cluster V was most divergent as well as early flowering. Cluster I was the best for yield while, cluster VII for test weight. Cluster II and VII were highly diverse from each other while, cluster VI and VIII were closely related. Geographical diversity did not relate to genetic diversity.

Genetic variability among 25 genotypes of maize was estimated by Alom et al. (2003) for eight traits. The genotypes were grouped into seven clusters. The inter cluster distances was larger than the intra cluster distance suggesting wider genetic diversity among the genotypes of different groups. The cluster III contained the highest number of genotypes with highest yield and 1000- grain weight. The inter cluster distance was highest between cluster III and II and of lowest between cluster IV and V. Intra cluster distance was highest in cluster IV and lowest for cluster VI.

2.2.1 Isozyme studies

Isozyme analysis has been used widely to estimate genetic diversity of populations. This method has been useful in addressing question on genetic structure of population and their conservation. Knowledge of the genetic diversity of species is particularly important. Since advance breeding practices involving selections for high biomass have narrowed the genetic diversity of cultivated crops. This reduction in genetic diversity could severely limit future breeding programmes for adaptive traits such as resistance to stress and stability.

Biochemical methods have been widely used for rapid identification of cultivars and detection of inheritance of multiple forms of single protein. Since their discovery isozymes have played a key role in many branches of biology and have become the most widely recognized links between the organisms and molecular approach. The advantage of using isozyme markers make them ideal for use in linkage studies for construction of genetic maps of plant chromosomes. The detection of isozyme of a specific enzyme depends upon plant age cell or tissue origin, growth environment and enzyme stability as well as method of extraction, separation and visualization (Sheen, 1983).

Isozyme polymorphisms have provided population geneticists and systematists with the simple genetic markers necessary to analyze gene flow, differential selection pressure and genetic relationships among populations and taxa. It has been repeatedly demonstrated that genetic diversity is correlated with genetic distance as measured by allozyme variation. (Brown and Weir, 1983). Many genera, including important crops, have been subjected to evolutionary and taxonomic

analysis involving isozymes surveys, such as *Zea* (Doebley *et al.* 1986; Kohler *et al.* 1986 and Smith *et al.* 1985)

Detection of isozyme using electrophoresis techniques has been extensively used for the characterization and identification of species, inbred lines, isogenic lines and crosses in plant breeding studies. In maize, enzyme diversity has mainly been studied to know the genetic variability in relation to geographical distribution and evolution.

Liu et al. (1981) reported P x 7 is the largest of the maize peroxidase isozymes, with a molecular weight of about 75000. The R_1 heterozygotes in crosses between P x 7R and P x 7S lines had only two bands which migrated together with each of the parental allelic bands, suggesting that P x 7, despite its high molecular weight behaved as a monomer. Hulton E. M. 1975. *Forage Res.*, 1: 87.

Khavkin (1991) noted variable bands of anodic esterase and peroxidase in zymogrames of leaf extracts from 8 second generation (SC_2) maize somaclones. The extent of variation within several sibs from the same SC, cob was sometimes greater than the deviation from the standard (line A188). Some of the bands active in the somaclones but absent from the leaves of the stand and were previously described as characteristics of other, not leaf tissue. Some loci appeared to te more succeptible to somaclonal variation than others.

Based on several studies (isozyme pattern) in *Maydeae*, least genetic distance was observed between *maize teosinte*. The hierarchical order of *Maydeae* is *maize* > *teosinte* > *coix* > *triolobanche* > *chionachne* (Sachan and Singh, 2001).

2.3 Character association and Path-Coefficient analysis

Knowledge of interrelationships serve two main purposes, firstly these are useful in selection of characters, which are not easily observed or genotypic values which are modified by the environmental effects. There is ample evidence to show that selection directly for yield is not easy. Thus, any morphological character that is associated with yield would be useful in the improvement of yield. Secondly, inter-

relationship between characters serves as a source of information to determine the nature, extent and direction of selection pressure to be applied on a character. Therefore, the character associations among yield traits and path co-efficient analysis for various yields and quality character of fodder and seed in maize are reviewed.

Simple correlation hardly takes into account the extremely complex inter-relationships. Path co-efficient analysis suggested by Wright (1960) and discussed by Li (1954 and 1956), Tukey (1954), Kempthorne (1957), Turner and Stewens (1959) and Neihour and Pickett (1966) involves partitioning of direct and indirect contribution of various factors towards building up of a complex correlation.

Chopra (1964) in his studies on genetic correlation between yield and number of cobs, days to flower, plant and cob length in maize, reported medium to high positive correlation between plant height and cob length.

Nanda (1964) studied general and specific combining ability of maize and obtained poor correlation for yield and shelling % but they were of sufficiently high magnitude for maturity characters, plant and cob length to have predictive value.

Chase and Nanda (1965) found positive and significant correlation between the average number of leaves per plant and average number of days to 50% anthesis.

Laszlo *et al.* (1969) in their studies on correlation among grain yield, 1000 grain weight, cob per plant and plant height observed significant correlations between 1000-grain weight and yield and dry matter content and yield. Other correlations were significant only under certain conditions.

Singh (1970) reported that seed yield was positively associated with cob length, cob girth and seed size in maize germplasm. From the path co-efficient analysis, it was shown that the cob girth was the most important component of yield.

Cross and Zuber (1973) evaluated ten strains of maize for interrelationship among plant height, number of leaves and flowering days and found significant correlation between plant height and number of leaves in majority of strains. The degree of relationship among the three characteristics varied among strains.

Sviridov (1979) reported close correlation between number of grains per cob and cob length (r=0.62) and also between number of leaves per plant and height (r=0.48).

Fairey (1980) made a study for the assessment of forage potential of maize and reported that forage yield was linearly related to grain yield at each site and this relationship was distinct for each site. However, grain yield was a good indicator for forage productivity. Forage dry matter content depended on the dry matter content of the stover and the preparation of total dry matter as grain or in the cob.

Regazzi *et al.* (1980) analyzed covariance and correlations in maize, which showed that genotypic correlations were greater than phenotypic in 17 out of 21 pairs of characters. From several of these correlations, it was concluded that in absence of lodging, yield was closely associated with plant height, height of cob insertion and number of cobs per plot.

Kumar (1982) studied genetic variability of quantitative characters contributing to forage yield in maize and reported that forage yield was highly correlated with leaf length, leaf number, leaf breath and plant height. Leaf length and cob weight were the main contributors to forage yield per plant.

Gallais *et al.* (1983) reported positive correlation of dry matter yield with cob length and plant height and negative correlation between dry matter yield and protein contents.

Dubas and Waligora (1984) made a three year investigation for assessment of the suitability of maize varieties for the production of grain and whole plant dry fodder. Correlations based on actual yield showed that when judged as a dual-purpose crop, some varieties failed to justify the promise of their high ranking.

Patel and Shelke (1984) observed that percent N content in the plant had significant correlation with forage yield, both directly and indirectly.

Paramathma and Balasubramanian (1986) observed that stem girth and plant height and leaf breath and stem girth were the most important traits for improving fodder yield in forage maize.

Forage yield may be increased by improving such characters like plant height, leaf area, N percentage, stem girth and number of internodes per plant. However,

Patel and Shelke (1988) reported positive and significant association among all the traits measured except leaf-stem ratio, leaves per plant, internodes per plant and dry matter yield per plant. Leaf area per plant exhibited positive and highly significant relationship with stem girth; internodes number and dry matter yield per plant.

Gupta and Singh (1990) studied genotypic and phenotypic association of leaf number, leaf area and dry leaf weight and found that all the characters were significantly and positively associated with sink size (grains/ kernel row) and ultimately with grain yield.

Correlation between grain yield and certain morphological characteristics were studied by Angelow (1992) who observed highly significant correlation between yield and plant height, number of leaves and length of the first cob. Correlation between yield and cob length and number of grains per cob were also significant. Yield was not correlated with number of grain rows per cob.

Partial and multiple correlations were carried out on yield and its components by Altinbas and Algan (1993). Partial correlations between earliness and other traits were non-significant, except for days to silking and grain row number. Multiple correlations of earliness with grain yield per plant, cob diameter and 100 grain weight were significant. Cob diameter was the major component of grain yield and grain yield per plant was positively affected by 100-grain weight.

Singh and Major (1993) reported that grain yield was associated with cob girth, rows per cob and grains per row. Path analysis indicated high direct effects of these three traits on grain yield.

Dost Mohammad *et al.* (1995) made a study on fodder yield and quality potential of forage maize and evaluated number of leaves per plant, green fodder yield and dry matter yield. Plant height and leaf area were positively correlated with green fodder yield and dry matter yield.

Rahman *et al.* (1995) found that grain yield was significantly and positively correlated with plant height, cob length, number of grains/cob and 1000 grain weight. Path analysis revealed that cob length, plant height and 1000 grain weight were main contributors to grain yield.

Choukan (1996) found that leaf- stem weight and stem weight showed the highest correlation with fodder yield (r = 0.97 and 0.96, respectively). Stem weight and plant weight had the highest correlation with forage yield/plant (r = 0.81 and 0.66, respectively).

Wang *et al.* (1997) derived information on yield correlation from data on 7 yield- related characters. Results showed that 100 seed weight, rows per cob, cob diameter and kernel/ row had the height correlation with grain yield.

Katiyar and Choudhary (1999) indicated that green fodder yield had positive correlation with plant height, number of leaves, leaf length, leaf width and dry fodder yield but it was negatively associated with crude protein content. Path coefficient analysis revealed the highest and positive contribution of plant height towards green fodder yield followed by leaf length, internode length, leaf/stem ratio and leaf width, respectively. Gurrath *et al.* (1989) and Geiger *et al.* (1992) also reported that green fodder yield was significantly and positively associated at phenotypic level with plant height, number of leaves, leaf length and leaf width.

Mani *et al.* (1999) made a study on variability and path coefficient analysis in indigenous maize. Results revealed that grain yield per plant had highly significant positive correlation with all the attributes and the highest was with cob weight per plant. Path analysis also suggested that cob weight per plant followed by grains per row were the major direct contributor to grain yield per plant. Hence, maize, breeders may concentrate much on cob weight/plant and grains per row as selection criteria for yield improvement.

Rana *et al.* (2000) studied the inter-relationships and path coefficient analysis in maize and computed phenotypic coefficient of correlation for grain yield and its component traits. Grain yield showed positive association with 1000 grain weight, kernels per row, cob length and plant height at the phenotypic level. Path coefficient analysis indicated that plant height and kernels per row were the main characters through which the indirect correlation of most of the traits was positive and higher. Similar results regarding to correlation coefficient for plant height with cob length (Krishnan and Natarajan, 1995) have been observed. Direct positive contribution of kernels per row and kernel rows per cob towards grain yield have been reported by

Gyanendra *et al.* (1993), whereas plant height was positively associated with kernels per row and 1000-grain weight reported by Debnath and Khan (1991).

2.4 Gene x Environment interaction and phenotypic stability

The study of genotype x environment interaction leads to successful evaluation of the stable genotypes, which could be used in future breeding programmes. Earlier Finlay and Wilkinson (1963) considered linear regression slopes as a measure of stability. Eberhart and Russell (1966) modified the techniques and considered both the linear (bi) and nonlinear (S^2di) components of genotype x environment interaction for judging the phenotypic stability of the variety. They used corn hybrids which were a highly selected material developed from improved inbreeds and suggested that an ideal variety should have high mean, linear regression and a (S^2di) as small as possible. Later on Breese (1969), Samuel *et al.* (1970), and Paroda and Hays (1971) advocated that the linear regressions could simply be regarded as a measure of response of a particular genotype, which in fact is dependent largely on the number of genotypes included in a particular study. Whereas, the deviations from regression line (S^{-2}_{di}) were considered as a better measure of stability. The genotypes with lowest squared deviations being the most stable and *vice versa.* Using the above definition of the term stability it could be possible to judge the phenotypic stability with due consideration to mean performance and linear response of the individual genotypes. Looking into different opinions for evaluating genetic materials for stability, a scale of stability was later on adapted in forage crops by Shukla *et al.* (1993) in lablab bean, and Singh *et al.*, (2000) in *Clitoria ternatea*. The scale spells out the parameters to be considered for evaluating stability of the genotypes as under:

Xi > GM: Grand mean of the populations (invariably for all the genotypes selected).

bi = 1: i th genotype predicted have stability for general or average environments.

bi > 1: i th genotype predicted has stability for favorable environments.

bi <1: i th genotype predicted have stability for stress or poor environments.

S^2di = NS: i th genotype predicted have to be stable

S^2di = Sig: i th genotype predicted has to be unstable, irrespective of the value for mean and regression coefficients

2.4.1 Genotype x Environment interaction:

The interaction of genotype to the environment is a natural phenomenon irrespective of the nature of the plant material *i.e.,* varietal population, pure lines, hybrids, clone populations and so on. Therefore, an understanding of genotype x environment interaction is obviously of great utility in plant breeding programme (Allard and Bradshaw, 1964). The capacity of a crop variety for yielding well over a range of environments is important as its yielding potential. This is especially so when the crop is grown under widely variable environmental conditions. A specified genotype does not exhibit the same phenotypic characteristics under all environmental conditions and the different genotypes respond differently to a specified environment. In other words the failure of a genotype to express the same phenotypic performance when grown under different environments is the reflection of genotype x environment interaction.

Environment is the sum total of physical, chemical and biological factors. Comstock and Moll (1963) classified the environments into two categories (I) Micro-environment, which is the environment of a single organism growing at the same time and in almost same place and (ii) Macro-environment, which is associated with a general location and period of time and is a collection of several micro environments.

Allard and Bradshaw (1964) coined the term predictable and unpredictable environments. The predictable environments included the permanent features of environment such as climate, soil type, day length etc. It also included the controlled variables as fertilizer level, sowing date, plant population, density etc. The unpredictable environment included the factors beyond human control *i.e.,* weather fluctuations in terms of temperature, rain fall, etc.

Jha *et al.* (1986) reported significant differences among genotypes for grain yield and for genotype x environment interactions. Partitioning of genotype x environment interaction showed significant mean squares due to genotype x environment (linear) and pooled deviations. High yielding hybrids showed wide adaptation for grain yield as indicated by near unit regression coefficient and non-significant deviation from regression.

Sain *et al.* (1987) evaluated eight varieties of maize for stability with respect to days to 50% silking, plant height, cob length, days to maturity and grain yield. Mean squares due to genotype x environment interactions were to be significant for all the characters except cob length and days to 50% silking.

V'Lchinkov (1992) reported genotype x environment interactions was significant for all traits except area of the leaf nearest to the cob and cob length. The phenotypic stability of the characters was close to the theoretical values, with no significant difference between the various hybrid types.

Pal and Prodhan (1994) studied genotype x environment interaction in maize and reported that pooled analysis of variance to be highly significant due to environments, genotypes and genotype x environment interactions for all the characters studied except cob diameter, and number of rows/cob. The results also suggest a greater influence of additive components of gene action in the expression of maturity, cob diameter and 100 grain weight.

Sedham (1994) evaluated ten maize genotypes under 8 environmental conditions to study their stability for grain yield. Significant genotypic effects and genotype x environment interactions were observed for grain yield/plant.

Reddy *et al.* (1998) studied stability of fodder yield in various types of maize. Result showed, the genotype x environment interaction to be significant for the linear

portion as well as on the non- linear portion but with a predominance of the former indicating that the genotypes responded in a linear manner. The high yielding genotype African Tall was better adapted to good or favorable environment, while Varun (a synthetic variety) was well adapted to poorer environments. The double-cross hybrid DHM 105 was stable over both poor and better environment having general adaptability.

2.4.2 Studies on adaptability & phenotypic stability

An adapted genotype or population is the one, which tolerates the selection pressure by surviving better than that of the stand under comparison. Adaptability is the capacity of the genotype to respond to the selection pressure and it depends on the provision of variability (Mather, 1943). Wild populations of plants and animals display a series of compromise between the two, which depends upon the present ecological circumstances, and the past evolutionary history. These compromises essentially depend upon the adjustment of recombination so that the advantages of close adaptation and disadvantages of concomitant restriction of variability are balanced.

Adaptation is the property of a genotype, which permits its survival under selection, while adaptability is the property of a genotype or the population of genotypes, which permits subsequent alteration of the norm of adaptation in response to change of the selection pressure (Simmond, 1962). In spite of the awareness of genotypic differences in adaptability, the plant breeders have not been able to exploit them fully in breeding programme, largely due to problems of defining and measuring either the adaptability itself or the complexities of natural environments. Various workers (Salmon, 1951; Horner and Frey, 1957; Sandison and Bartlett, 1958) have discussed some of the methods and problems of comparing varietal performance in several environments for several years.

Plaisted and Peterson (1959) suggested a method to characterize the stability of yield performance when several varieties were tested at a number of locations within one year. This method involved computation of a combined analysis of variance over all locations for each pair of varieties. This method has been of limited

utility because of the large number of analysis required. Finlay and Wilkinson (1963) reported a simple technique to measure adaptability of varieties based on average yield of the varieties and their regression coefficients.

Eberhart and Russell (1966) further modified the techniques and considered both the linear (bi) and nonlinear (S^2di) components of genotype x environment interaction for judging the phenotypic stability of the variety. They used corn hybrids which were a highly selected material developed from improved inbreds and suggested that an ideal variety should have high mean, linear regression and a non-linear component (S^2di) as small as possible.

Perkins and Jinks (1968) further modified the model of the Stability estimate. Paroda and Hayes (1971) observed that the linear regression should simply be considered as measure of response of a genotype, whereas, the deviations around the regression line is a measure of stability. They also pointed out that a genotype with lowest deviation might be the most stable and *vice versa.*

Gamma and Hallauer (1980) reported significant association between mean yield and regression coefficient and between mean yield and deviation from regression, but these were not large enough to have predictive value.

Paradkar *et. al*. (1995) evaluated seven genotypes of maize for phenotypic stability with respect to grain yield and its components under micro and macro environments. Genotype x environment interaction was observed for all the characters except plant height and number of grain row per cob. Genotype J3022 with the highest grain yield had average stability for most of the characters under the different environmental conditions. Early genotypes were also very stable in the different environments. Genotypes R2 and VL 88 exhibited above average stability for grain yield in poor environments, while R5 was most stable in better environments.

Gautam *et al.* (1998) derived information on stability from data on grain yield. They observed significant difference due to genotype, environment and genotype environment interaction. The local landrace had the highest average yield and was most suited to temperate wet locations of Himachal Pradesh.

Nirala and Jha (2003) studied the phenotypic stability for fodder traits in maize and reported highly significant mean squares due to genotypes and environments (linear) for all the traits under study indicating the presence of significant difference among genotypes and environments. Highly significant mean square due to genotype x environment (linear) for days to 50% silk and plant height revealed linear response for these traits. Highly significant mean square due to pooled deviation for all traits studied exhibited importance of non- linear component of genotype x environment interaction. The crosses GBM 84- 3 x African Tall and APFM 8 x African Tall were identified as high yielding and stable.

Chapter - III
Materials & Methods

MATERIALS AND METHODS

In present study a core collection of maize (*Zea mays* L.) accessions were evaluated with a control variety African Tall to study the nature and magnitude of genetic variability, divergence, character association and stability for various quality and quantitative traits of the fodder as well as seed yield. The experiments were conducted on same lines under three different environments.

This core collection was selected from the entire genetic diversity collected from the different parts/ eco-geographical location of the country. This genetic stock is being maintained at gene bank of Indian Grassland and Fodder Research Institute, Jhansi. Most of these genetic lines were initially explored and collected from the states of Rajasthan, Madhya Pradesh and Uttar Pradesh under NATP sub project on Sustainable Management of Plant diversity (Table: 3.1). A leading forage maize variety African Tall was also included in this study.

3.1 Experimental site

The experiment was conducted at the Central Research farm of Indian Grassland and Fodder Research Institute, Jhansi (78° E longitude, 25° N latitude and 271metre altitude). The site is located in the semi-arid transitional zone of the central India characterized by undulating topography, variable soils, and sub-tropical climate with low to very high (above 45°C) temperature. The average rainfall is around 800-900 mm, distributed over a period of 40-50 days during *Kharif* (July to September) and about 5-10 days in *Rabi* season (November to March).

Table 3.1: Detail of the 101 maize accessions

S. No.	Accession No.	Area of collection		
		Village	District	State
1.	IC- 334821	Sawai Man	Jaipur	Rajasthan
2.	IC- 334825	Kheragardi	Rajsamand	Rajasthan
3.	IC- 334826	Kheragardi	Rajsamand	Rajasthan
4.	IC- 334830	Pitampura	Rajsamand	Rajasthan
5.	IC- 334833	Pitampura	Rajsamand	Rajasthan
6.	IC- 334834	Pitampura	Rajsamand	Rajasthan
7.	IC- 334836	Miarei	Rajsamand	Rajasthan
8.	IC- 334837	Miarei	Rajsamand	Rajasthan
9.	IC- 334838	Miarei	Rajsamand	Rajasthan
10.	IC- 334841	Miarei	Rajsamand	Rajasthan
11.	IC- 334842	Pritia	Rajsamand	Rajasthan
12.	IC- 334846	Pritia	Rajsamand	Rajasthan
13.	IC- 334848	Pritia	Rajsamand	Rajasthan
14.	IC- 334853	Kavita	Rajsamand	Rajasthan
15.	IC- 334855	Darwaza	Udaipur	Rajasthan
16.	IC- 334863	Simta	Udaipur	Rajasthan
17	IC- 334864	Galahoton ka Guda	Udaipur	Rajasthan
18.	IC- 334867	Galahoton ka Guda	Udaipur	Rajasthan
19.	IC- 334869	Bakeria	Sirohi	Rajasthan
20.	IC- 334871	Oria	Sirohi	Rajasthan
21.	IC- 334872	Oria	Sirohi	Rajasthan
22.	IC- 334876	Oria	Sirohi	Rajasthan
23.	IC- 334877	Oria	Sirohi	Rajasthan
24.	IC- 334879	Barajar	Sirohi	Rajasthan
25.	IC- 334880	Barajar	Sirohi	Rajasthan
26.	IC- 334881	Barajar	Sirohi	Rajasthan
27.	IC- 334884	Barajar	Sirohi	Rajasthan
28.	IC- 334889	Rajgarh	Dungarpur	Rajasthan
29.	IC- 334904	Barwat	Banswara	Rajasthan
30.	IC- 334915	Chotti Sukhan	Banswara	Rajasthan
31.	IC- 334920	Charawra Gait	Ratlam	Rajasthan
32.	IC- 334929	Shragaingarh	Ratlam	Rajasthan
33.	IC- 334932	Shragaingarh	Ratlam	Rajasthan
34.	IC- 334942	Majarpur	Ujjain	Madhya Pradesh
35.	IC- 334943	Majarpur	Ujjain	Madhya Pradesh
36.	IC- 334944	Majarpur	Ujjain	Madhya Pradesh
37.	IC- 334945	Majarpur	Ujjain	Madhya Pradesh
38.	IC- 334947	Mopakher	Sajapur	Madhya Pradesh
39.	IC- 334949	Mopakher	Sajapur	Madhya Pradesh
40.	IC- 334954	Borda	Jhalawar	Rajasthan
41.	IC- 334955	Borda	Garhi	Rajasthan
42.	IC- 334957	Sakaria	Garhi	Rajasthan
43.	IC- 334973	Salempur	Kannauj	Uttar Pradesh
44.	IC- 334974	Salempur	Kannauj	Uttar Pradesh
45.	IC- 334989	Sarai Sunder	Kannauj	Uttar Pradesh
46.	IC- 334996	Ruppur	Kannauj	Uttar Pradesh
47.	IC- 334999	Ruppur	Kannauj	Uttar Pradesh

Contd…

Contd...

49.	IC- 335009	Pattikhud	Farrukhabad	Uttar Pradesh
50.	IC- 335017	Dhirpur	Farrukhabad	Uttar Pradesh
51.	IC- 335024	Kureli	Farrukhabad	Uttar Pradesh
52.	IC- 335025	Kureli	Farrukhabad	Uttar Pradesh
53.	IC- 335027	Kureli	Farrukhabad	Uttar Pradesh
54.	IC- 335028	Kureli	Farrukhabad	Uttar Pradesh
55.	IC- 335032	Allawalpur	Farrukhabad	Uttar Pradesh
56.	IC- 335035	Allawalpur	Farrukhabad	Uttar Pradesh
57.	IC- 335041	Nagla Simi	Farrukhabad	Uttar Pradesh
58.	IC- 335043	Nagla Simi	Farrukhabad	Uttar Pradesh
59.	IC- 335045	Nagla Simi	Farrukhabad	Uttar Pradesh
60.	IC- 335048	Nagla Simi	Farrukhabad	Uttar Pradesh
61.	IC- 335050	Nagla Simi	Farrukhabad	Uttar Pradesh
62.	IC- 335051	Nagla Simi	Farrukhabad	Uttar Pradesh
63.	IC- 335053	Ahirwa	Hardoi	Uttar Pradesh
64.	IC- 335056	Ahirwa	Hardoi	Uttar Pradesh
65.	IC- 335060	Ahirwa	Hardoi	Uttar Pradesh
66.	IC- 335062	Ahirwa	Hardoi	Uttar Pradesh
67.	IC- 335068	Bhanayal	Hardoi	Uttar Pradesh
68.	IC- 335069	Banekeuya	Hardoi	Uttar Pradesh
69.	IC- 335079	Gaushganj	Hardoi	Uttar Pradesh
70.	IC- 335082	Gaushganj	Hardoi	Uttar Pradesh
71.	IC- 335086	Kethipurwa	Hardoi	Uttar Pradesh
72.	IC- 335089	Baghoura	Hardoi	Uttar Pradesh
73.	IC- 335092	Baghoura	Hardoi	Uttar Pradesh
74.	IC- 335094	Baghoura	Hardoi	Uttar Pradesh
75.	IC- 335098	Bisenpur	Kannauj	Uttar Pradesh
76.	IC- 335103	Kalsan	Kannauj	Uttar Pradesh
77.	IC- 335109	Kalsan	Kannauj	Uttar Pradesh
78.	IC- 335110	Kalsan	Kannauj	Uttar Pradesh
79.	IC- 335111	Kalsan	Kannauj	Uttar Pradesh
80.	IC- 335112	Kalsan	Kannauj	Uttar Pradesh
81.	IC- 335115	Bisenpur	Kannauj	Uttar Pradesh
82.	IC- 335116	Bisenpur	Kannauj	Uttar Pradesh
83.	IC- 335117	Budia	Kannauj	Uttar Pradesh
84.	IC- 335120	Budia	Kannauj	Uttar Pradesh
85.	IC- 335122	Budia	Kannauj	Uttar Pradesh
86.	IC- 335128	Budia	Kannauj	Uttar Pradesh
87.	IC- 335131	Ratanpurva	Kannauj	Uttar Pradesh
88.	IC- 335138	Ratanpurva	Kannauj	Uttar Pradesh
89.	IC- 335141	Ratanpurva	Kannauj	Uttar Pradesh
90.	IC- 335144	Bharin	Kannauj	Uttar Pradesh
91.	IC- 335148	Bharin	Kannauj	Uttar Pradesh
92.	IC- 335149	Bharin	Kannauj	Uttar Pradesh
93.	IC- 335152	Bharin	Kannauj	Uttar Pradesh
94.	IC- 335156	Ashkaranpur	Kannauj	Uttar Pradesh
95.	IC- 335158	Ashkaranpur	Kannauj	Uttar Pradesh
96.	IC- 335164	Malhapur	Kanpur	Uttar Pradesh
97.	IC- 335169	Malhapur	Kanpur	Uttar Pradesh
98.	IC- 335173	Mithua	Kanpur	Uttar Pradesh
99.	IC- 335178	Mithua	Kanpur	Uttar Pradesh
100.	IC- 335184	Rajapur	Kanpur	Uttar Pradesh
101.	African Tall	-	-	-

Fig. 3.1 Range of temperature variation during the crop period

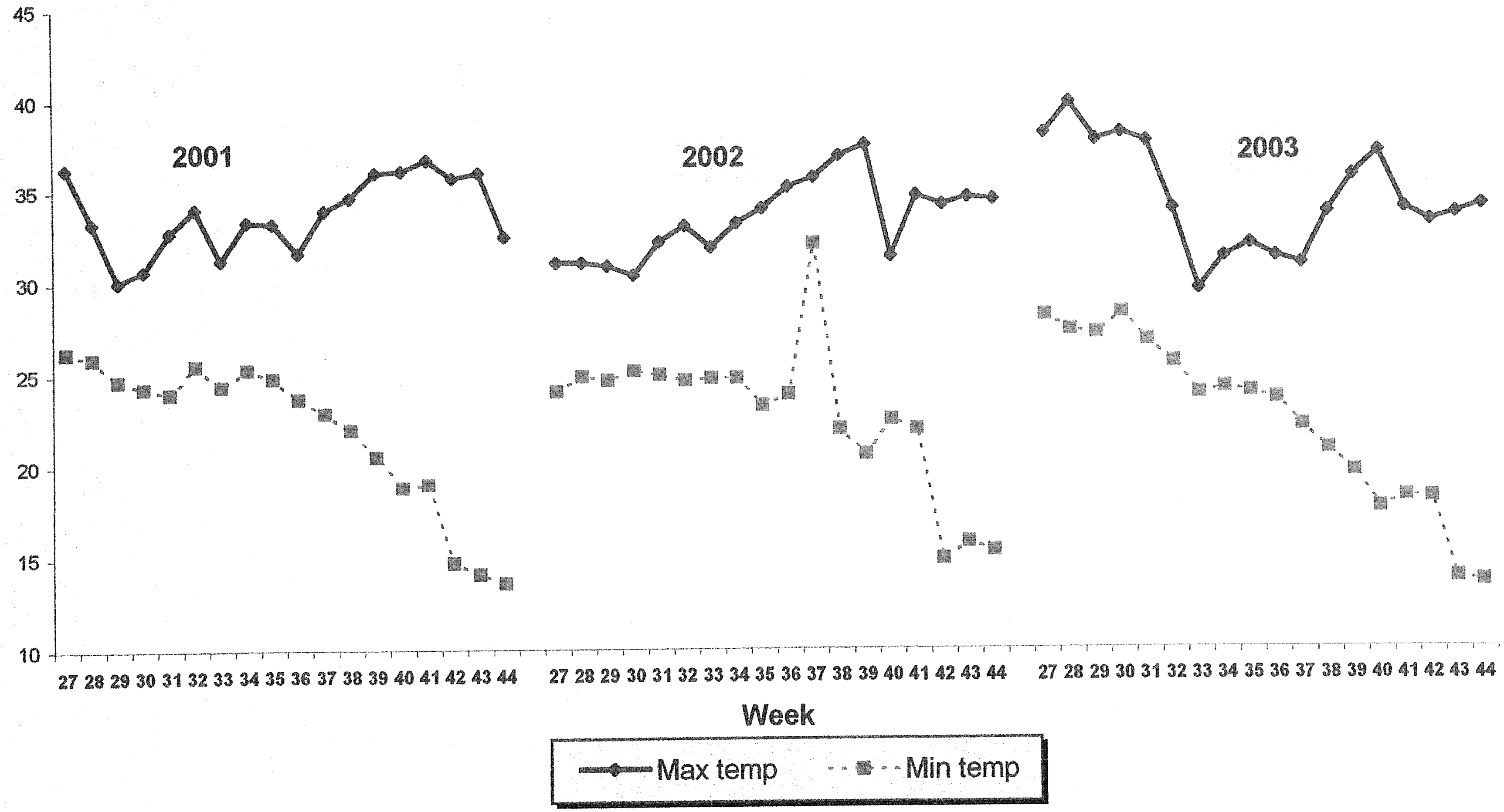


Fig. 3.2 Range of relative humidity during the crop period

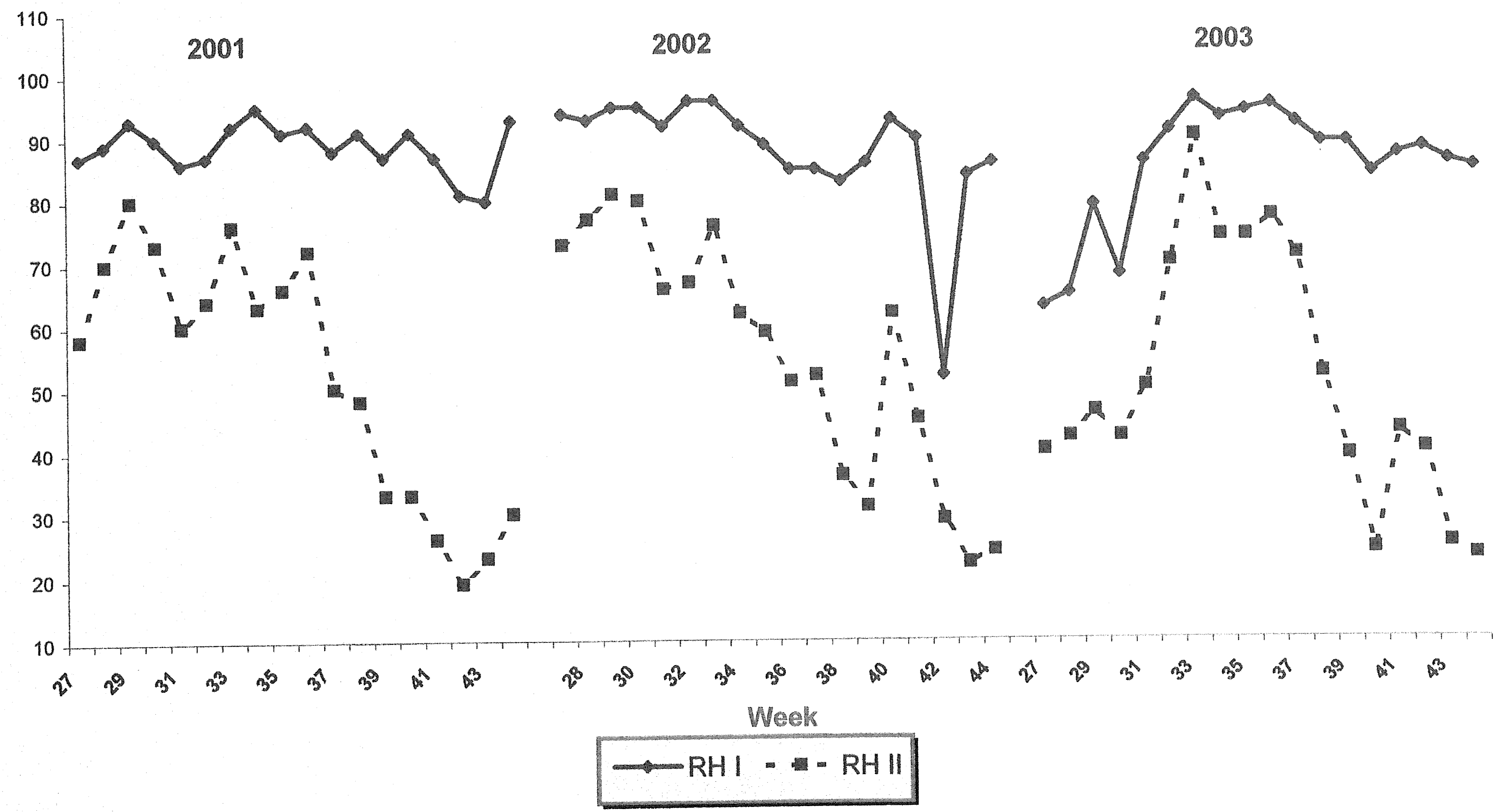


Fig. 3.3 Rainfall and rainy days during the crop period

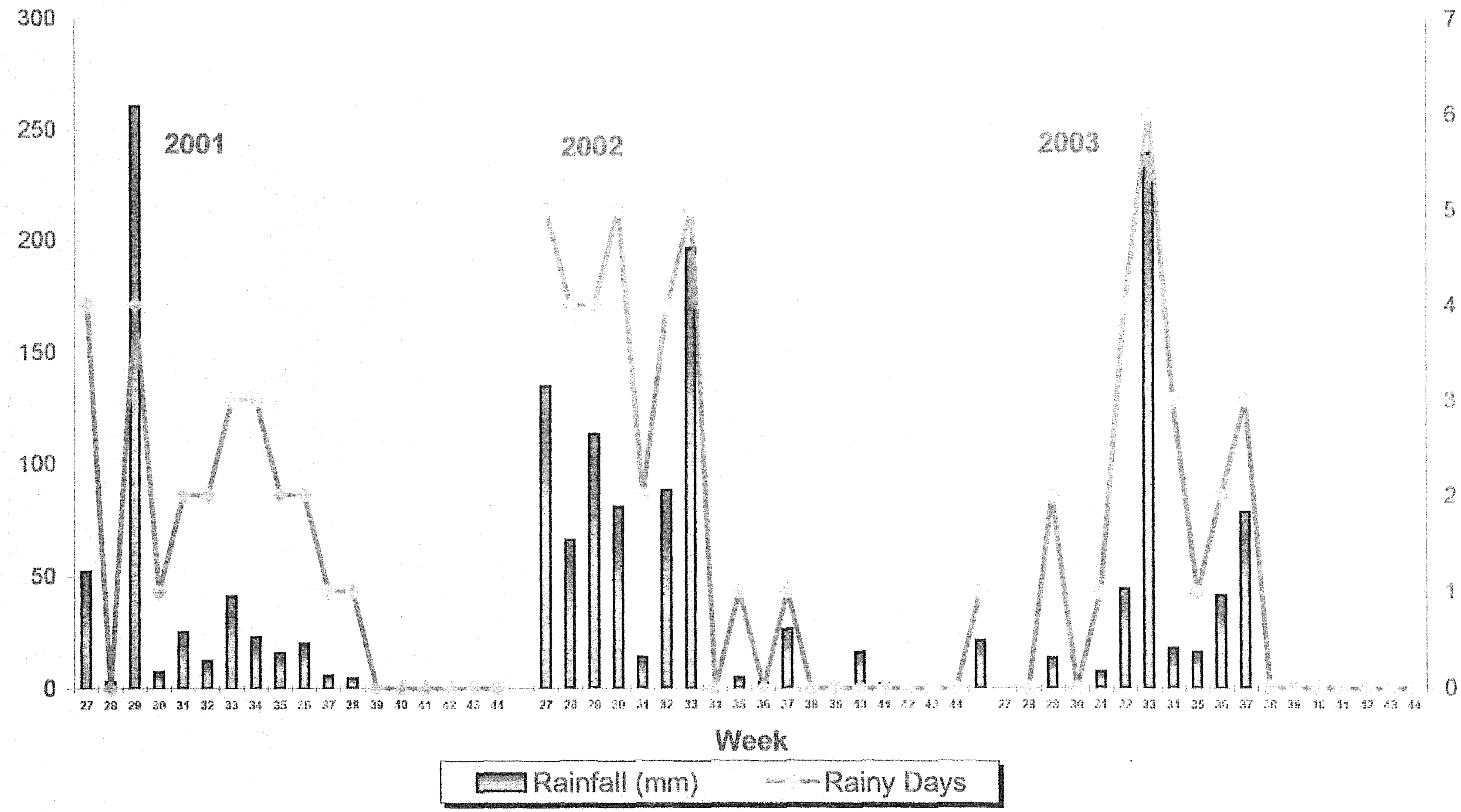
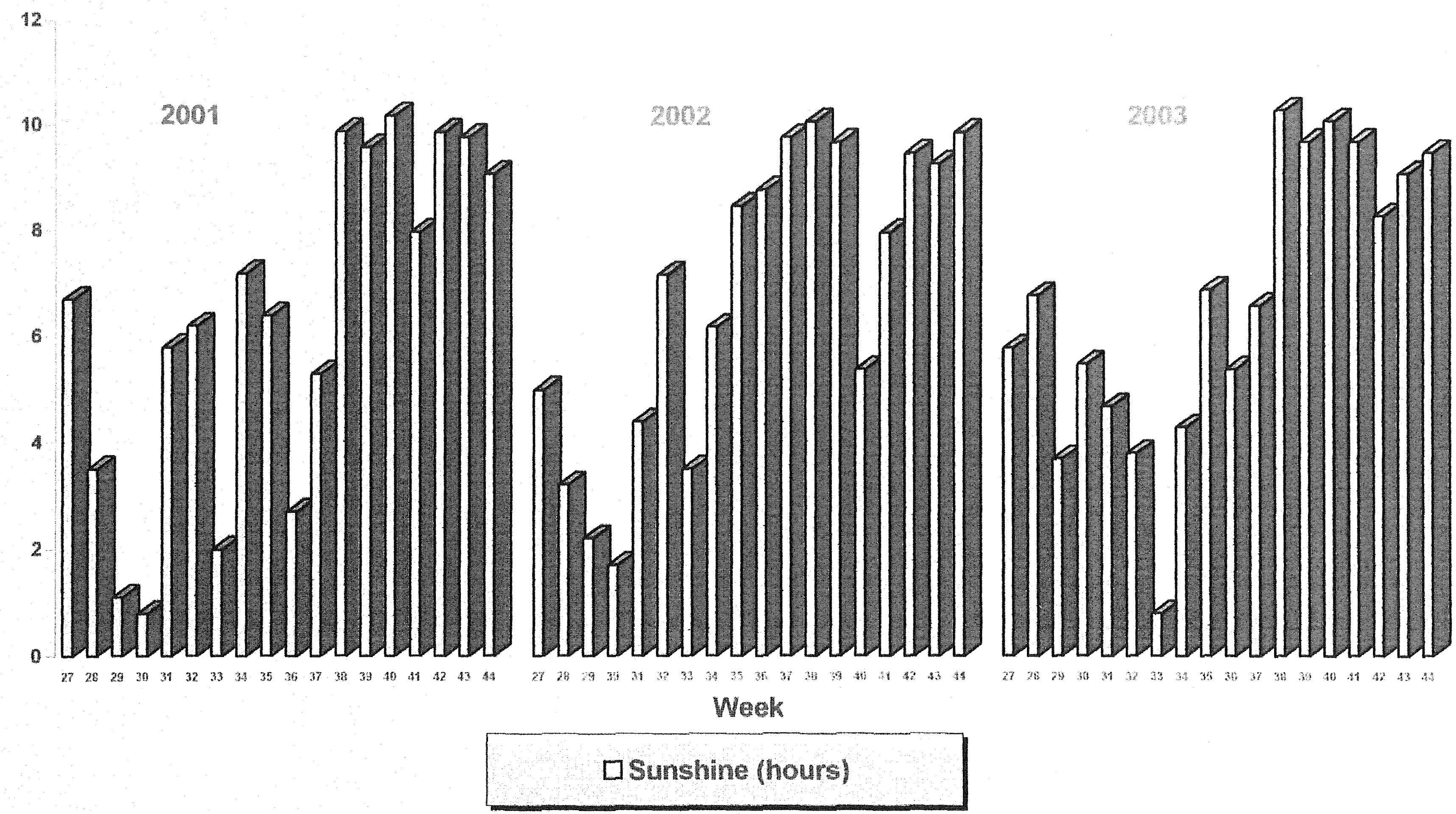


Fig. 3.4 Sunshine variation during the crop period



3.2 Weather condition

The details of the meteorological parameters like temperature (Max. & Min.), relative humidity (Max. & Min.), rainfall and number of rainy days and duration of bright sunshine hours for the crop season of 2001 - 2003 as recorded at the meteorological observatory unit of Indian Grassland and Fodder Research Institute, Jhansi are presented in figure 3.1 to 3.4.

3.3 Experimental layout

The present investigation embodied experiment in three environments to study the various growth, yield and quality parameters in forage maize. During investigation a set of 101 accessions was raised during *Kharif* (first week of July 2001, 2002 & 2003) as a rain fed crop on a comparatively better-textured sandy loam soil (Parawa) with average moisture holding capacity.

Each entry was sown in randomized block design having three replications on well-prepared land with optimum moisture for germination. Each entry was grown in paired row plot of 4-meter length keeping 0.75-meter distance between the rows and 0.15-meter between the plants within a row. Standard agronomic practices were followed and recommended fertilizer dose were applied during the course of experiment.

3.4 Recording of data

Observation on various parameters contributing to fodder yield potential were recorded at 50% silking stage of the accessions, whereas the data on seed yield and its attributes were recorded at maturity of the plants. The data were recorded on following characters as –

3.4.1 Qualitative characters

i) Leaf blade colour

Leaf blade colour was classified as light green (LG) or dark green (DG).

ii) **Sheath colour**

Sheath colour was classified as light green (LG) or dark green (DG).

iii) **Midrib colour**

This trait was classified as white or reddish brown midrib.

iv) **Stem colour**

Stem colour was classified as light green (LG) or dark green (DG).

v) **Kernel colour**

This trait was classified as dark yellow (DY), light yellow (LY), white (W), variegated (V), brown (B) and yellow (Y) kernels.

vi) **Kernel row arrangement**

Kernel row arrangement was classified as regular, straight, irregular and spiral rows.

vii) **Kernel shape**

This trait was classified as shrunken, round, indented and pointed shape.

viii) **Kernel size**

This observation was recorded as small, medium and bold type kernels.

ix) **Cob shape**

This shape was classified as cylindrical or conical cob shape.

3.4.2 Quantitative characters

(A) Fodder yield characters

Data on fodder yield were recorded on three randomly selected plants at 50% silking stage of each accession on following characters:

i) **Days to 50% silking**

Throughout the flowering period daily observations were made on all plants in each treatment row to determine the date on which silk were visible on 50% of the plant population. Days to 50% silking were calculated from the date of sowing of the experiment.

ii) **Plant height (cm)**

The plant height was measured from the ground level to the base of the tassel.

iii) **Number of leaves per plant**

A count of total number of leaves was taken from basal node to uppermost node.

iv) **Leaf blade length (cm)**

This measurement was made from the base to the tip of the leaf of seventh node of the main shoot.

v) **Sheath length (cm)**

It was measured from base attachment of leaf on node to the next node.

vi) **Leaf width (cm)**

Width of leaf was measured at the widest margin of the leaf lamina.

vii) **Stem girth (cm)**

The thickness of the stem was measured at fifth node from the base of the shoot.

viii) **Green fodder yield/plant (g)**

Green biomass of the plant above the ground level was weighed (at 50% flowering stage) just after the cutting.

ix) **Dry fodder yield/plant (g)**

Green biomass of plant sample was put in an oven at 60°C for 48 hrs, and dried sample was weighed.

x) **Leaf - stem ratio**

Leaf - stem ratio was worked out by dividing leaf weight by stem weight per plant (on dry matter basis).

xi) **Quality components (CP content %)**

Estimation of the crude protein content was done as per the method suggested in A.O.A.C. (1990). For this 1g oven dried and grounded dry fodder sample was taken and the catalyst mixture ($CuSO_4$ and K_2SO_4 in a ratio of 1: 5) was added. Further, digestion was done with 20 ml conc.

H_2SO_4 for 2-3 hours till it became transparent. Volume was made up to 100 ml in the volumetric flask by adding distilled water. From this flask 5.0 ml solution was taken and distilled in micro Kjeldahl distillation apparatus with 40% NaOH. Released ammonia was collected in beaker containing 4 % boric acid mixed with indicator (methyl red). The colour of indicator changed from red to blue as released ammonia gas was absorbed by boric acid and ammonium borate was formed. Then ammonium borate was titrated with standard solution of N/100 H_2SO_4.

Finally 'N' percentage was calculated as:

01 ml of N/100 H_2SO_4 = 0.00014 g N. Percent nitrogen was converted to percent crude protein content by multiplying the percent N by a factor of 6.25.

Crude protein (%) = (%) N X 6.25

(B) Seed yield characters

In addition to days to 50% silking and plant height, the following characters, which are the major components for seed yield, were also studied.

i) Days to maturity

Days to maturity were recorded as number of days from the date of sowing to 80% maturity of the crop.

ii) Cob length (cm)

It was measured from the shank to the tip of the cob.

iii) Cob width (cm)

This measurement was made at mid point along the length of cob.

iv) Number of kernel rows

It was calculated as number of kernel rows in central part of the cob.

v) Number of kernels/row

Number of kernels per row was counted from the base to the tip of the cob.

vi) Kernel length (cm)

The length of three healthy kernels per cob was measured to calculate kernel length.

vii) Kernel width (cm)

The width of three healthy kernels per cob was measured to calculate kernel width.

viii) Test weight (g)

100 healthy seeds of each genotype were weighed to find out test weight.

ix) Seed (kernel) yield per plant (g)

Threshed kernel yield obtained from the three healthy plants were weighed to calculate kernel yield per plant.

3.4.3 Analysis of isozymes

Thirteen maize accessions from different geographical locations, including African Tall were compared for three enzyme systems namely esterase (EST), Super oxide desmutase (SOD) and Peroxidase (PRX).

Thirteen maize accessions from different geographical location

Sr. No	Accession No.	District	State
1	IC- 334836	Rajsamand	Rajasthan
2	IC- 334954	Jhalawar	Rajasthan
3	IC- 334879	Sirohi	Rajasthan
4	IC- 334515	Banswara	Rajasthan
5	IC- 335017	Farrukhabad	Uttar Pradesh
6	African Tall	-	-
7	IC- 335111	Kannauj	Uttar Pradesh
8	IC- 335173	Kanpur	Uttar Pradesh
9	IC- 334853	Rajsamand	Rajasthan
10	IC- 334945	Ujjain	Madhya Pradesh
11	IC- 335053	Hardoi	Uttar Pradesh
12	IC- 335069	Hardoi	Uttar Pradesh
13	IC- 334929	Ratlam	Madhya Pradesh

What was the basis of selection of these accessions ?

The following methods were used:

Polyacrylamide gel electrophoresis (PAGE)

PAGE analysis was done using polyacrylamide vertical gel electrophoresis system.

Preparation of stock solution and buffers:

1. **Grinding buffer:** 0.168 gm of EDTA (5.75 mM) was dissolved in double distilled water. In this solution 5 gm of sucrose (5%) and 0.605 gm Tris buffer (50 mm) was dissolved, then the volume of the solution was made up to 100 ml by double distilled water. 0.1 ml of marceptophenol was added in the grinding buffer solution and stored at 4°C and the pH was adjusted to 8.8.
2. **Collection of samples:** The leaves sample was collected from the field into the icebox. Then the crude extract from the leaves was prepared by homogenizing the sample in grinding buffer (1:3 ratio *ie.* 1 gm leaf sample in 3 ml grinding buffer) and little amount of sterilized sand particles in a pre-chilled pestle. The crude extract was centrifuged at 10,000 rpm for 15 minutes at 4°c. The pellet was discarded and supernatant stored at 0 to –5° c.
3. **Acrylamide Stock Solution (Separating gel):** Acrylamide stock solution for separating gel, was prepared by dissolving 29.2 gm acrylamide and 0.8 gm of bisacrylamide in double distilled water and final volume was made up to 100 ml. Solution was stored at 4°C in amber colored bottle.
4. **Tris HCl buffer for separating (Resolving gel) pH 8.8:** 18.15 gm of Tris was dissolved in 60 ml. of water and pH was adjusted to 8.8 by adding drops of conc. HCl and final volume was made up to 100 ml using double distilled water.
5. **Tris HCl buffer for stacking gel (pH 6.8):** 6.1 gm of Tris dissolved in 60 ml water and pH was adjusted to 6.8 by adding drops of conc. HCl and final volume was made up to 100 ml.
6. **Ammonium Per Sulphate (APS):** 100 mg of ammonium per sulphate dissolved in 1 ml distilled water. This solution was prepared fresh each time.

7. **Running gel electrode buffer (pH 8.3):** Electrode buffer was prepared by adding 2.1 gm glycine, and 450 mg of Tris. Volume was made up to 750 ml by adding double distilled water.
8. **Tracking dye:** Tracking dye was prepared by mixing 0.25% bromophenol blue with 40% sucrose dilution solution.

Preparation of resolving gel:

40 ml of 10% resolution gel was prepared by adding acrylamide (30%, 13.3 ml), Tris HCl (8 ml), H_2O (18.1 ml), TEMED (20 µl) and APS (10%, 200 µl). The gel solution was immediately poured in vertical gel casting unit and left for one hour for setting in undisturbed condition at the top of resolving gel 5 ml of water was poured so that the gel does not get dry.

Preparation of stacking gel:

5% stalking gel was prepared by adding acrylamide (30%, 1.7 ml), Tris HCl (1.3 ml), H_2O (6.9 ml), TEMED (10 µl) and APS (50 µl). 10 ml of this gel solution was poured over the resolving gel after removing the top level of water. After placing comb, stacking gel was poured. This gel was left for overnight. 50 µl sample was mixed with 10 µl of tracking dye; from this mixture 50 µl of sample was loaded in each well, after removing the comb.

Electrophoresis:

The prepared gel plate was placed in "Genei" vertical migration chamber. Running gel electrode buffer was poured into the migration chambers so that electrodes were completely dipped. A constant volt of 100 V was given till the tracking dye crossed the stacking gel. After this current was increased to 200 V till the tracking dye reached the bottom of the gel.

Staining:

Esterase: 100 ml of 0.1 m phosphate buffer (pH 6.5) 32.5 mg of α-naphthyl acetate in 1 ml. acetone and 50 mg fast blue RR was prepared. Gel was

incubated in this solution for 20 minutes. The esterase enzyme activity was observed as reddish brown to blackish bands of the gel.

Super oxide desmutase (SOD): The gel was stained in 100 ml of Tris HCl buffer (pH 8.65) in which Riboflavin (4 mg), EDTA (2 mg) and NBT (20 mg) were added. The gel was incubated in dark for 30 minutes and then exposed to intense light for some time until bands appear.

Peroxidase: 100 mg benzidine was dissolved in hot 100 ml of 0.2 M acetate buffer (pH 5.6). After cooling the benzidine solution, 1 ml of 3% hydrogen peroxide was added. After 10 minutes of incubation blue bands appeared which turned brown later.

3.5 Statistical Procedures

Statistics as a subject provide a body of principles and methodology for designing the process of data collection, summarizing and interpreting the data and drawing conclusion or generalities. Hence, with the help of statistical process to determine the extent of genetic variability and its range in the material under study was the primary objective of the present investigation. Yield being the most complex feature of the plant is difficult to be studied as such. Its real evaluation implies the extent to which each character contributes to it. To achieve this objective, yield must be broken down into its component factors and studying each factor separately as well as in combination with each other. Thus, the observations made on various traits were subjected to following statistical analysis.

3.5.1. Analysis of variance

Variation among the accessions for different quantitative traits was tested for significance, using ANOVA technique (Panse and Sukhatme, 1967) separately for individual environment and over pooled environments to find out their performance.

The following mixed effect linear model was used:

$$Y_{ij} = m + g_i + r_j + e_{ij}$$

Where,

Y_{ij} = phenotypic observation of i^{th} genotype in j^{th} replication.

m = general mean

r_j = effect of j^{th} replication

g_i's = genotypic effects which are random variable, distributed independently and identically as N (0, $\sigma^2 g$)

e_{ij}'s = errors associated with the (ij) observations, distributed independently and identically as N (0, $\sigma^2 g$)

The skeleton of the analysis of variance:

ANOVA

Source	df	ss	ms	F value
Replications	(r-1)	mr		
Genotypes	(g-1)	mt	$\sigma^2 e + r\, \sigma^2 gi$	mt /me
Error	(r-1) (g-1)	me	$\sigma^2 e$	
Total	(rt-1)			

Where,

g = number of genotypes

r = number of replications

mr, mt and me stand for sum of squares due to replication, treatments and error, respectively.

The phenotypic, genotypic and error variances were estimated as follows:

Error variance = $\sigma^2 e$ = me

Genotypic variance = $\sigma^2 g$ = (mt-me)/r

Phenotypic variance = $\sigma^2 p = \sigma^2 g + \sigma^2 e$

3.5.2 Components of variability

(a) Mean:

The mean or average value of each character was computed as the sum of the measurement divided by their number.

Thus,

$$\overline{x} = \frac{\Sigma x}{n}$$

Where $\overline{x}$ = sample mean

Σx = summation

n = number of measurement in the sample

(b) Range

It was estimated as the difference between the lowest and highest values present in the measurement of each character.

(c) Standard error (SE)

Standard error of mean was calculated with the help of error mean square from the analysis of variance. Thus,

$$SE = \sqrt{\frac{2\sigma^2_e}{r}}$$

Where, σ^2_e = error variance

r = number of replications

(d) Critical difference (CD)

Critical difference was calculated to compare the treatment means for all the characters using the formula:

$$CD = \sqrt{\frac{2\sigma^2_e}{r}} \times \text{'t' table value at error df.}$$

(e) Coefficient of variation (CV)

Coefficient of variation was calculated as follows:

$$CV (\%) = \sqrt{\frac{\sigma^2_e}{\bar{X}}}$$

σ^2_e = error variance

$\bar{X}$ = Mean

(f) Genotypic coefficient of variation

It is calculated as:

$$GCV = \sqrt{\frac{\sigma^2_g}{\bar{X}}} \times 100$$

$$\sigma^2_g = \frac{Mv - Me}{r}$$

Mv = genotypic variance

Me = error variance

r = number of replication

X = mean

(g) Phenotypic coefficient of variation

It is calculated as:

$$PCV = \sqrt{\frac{\sigma^2_p}{X}} \times 100$$

Where, $\sigma^2_p = \sigma^2_g + \sigma^2_e$

(h) Heritability (h^2)

The heritability (in broad sense) was calculated according to the formula suggested by Allard (1960).

$$h^2 = \frac{\sigma^2_g}{\sigma^2_g + \sigma^2_e} \times 100$$

Where, σ^2_g = Genotypic variance

(i) Expected genetic advance

The genetic advance (GA) was calculated as percent of mean by the formula given by Johnson *et al.*, (1955).

$$\text{Expected genetic advance (as \% of mean)} = \frac{\sigma^2 g \times k}{\sigma^2_p \times \text{mean}} \times 100$$

Where k = Selection differential at [5% selection intensity k = 2.06]

σ^2_g = Genotypic variance of the characters

σ^2_p = Phenotypic variance of the character.

3.5.3 Cluster analysis (Genetic divergence)

The metric traits data was analyzed statistically using non-hierarchical Euclidean cluster analysis of grouping of genotypes (Spark, 1973). The replicated data were averaged over replicates and then cluster analysis was performed. The computer software SPAR 1 release 1.1 (IASRI, New Delhi) was used for computation.

3.5.3.1 Analysis of genetic divergence using isozymes:

The zymograms were recorded and the bands were scored as present (1) or absent (0) and were analyzed using NTSYS (Rohlf, 1993) for understanding the genetic diversity among the accessions. A matrix of simple matching coefficients was generated using the zymogram data and a dendrogram was generated with the unweighed pair-group method using an arithmetic average (UPGMA), according to Sneath and Sokal (1973).

3.5.4 Correlation and path coefficients analysis

(a) Correlation coefficient (r)

Phenotypic correlation coefficients over three environments were computed by the following formula:

$$r_{xy} = \frac{CV\,(XY)}{\sqrt{Var.\,(X) \times Var.(Y)}}$$

Where,

CV (XY) = Covariance of characters X and Y

Var. (X) = Variance of character X

Var. (Y) = Variance of character Y

To test the significance of phenotypic correlation coefficients, the estimated values were compared with the table values (Fisher and Yates, 1957) at n-2 degrees of freedom at 5% and 1% level of significance, where n being the sample size on which correlation is based.

(b) Path- coefficient analysis

Path analysis was done as described by Dewey and Lu (1959), and Ramanujam and Rai (1963) to assess direct and indirect influence of various component characters on dry fodder and grain yield.

The residual factors, i.e., the variation in yield unaccounted for those other associated factors was calculated from the following formulae:

Residual factor (%) = $1-R^2$

Where,

$R^2 = p_{1y}\, r_{1y} + p_{2y}\, r_{2y} + \ldots\ldots\ldots p_{ny}\, r_{ny}$

$R^{2,}$ is the square multiple correlation coefficients and is the amount of variation in yield that can be accounted for the yield component characters.

3.5.5 Gene x Environment interaction & stability analysis

Eberhart and Russell's model (1966)

Although the pooled analysis of variance provided the useful estimate, yet the information about adaptation of individual genotype could not be available from the conventional method. Hence, the method suggested by Finlay and Wilkinson (1963), which was later on modified by Eberhart and Russell (1966) was applied in this investigation in order to obtain the estimate of various stability parameters for each genotype under consideration.

The stability analysis technique partitions the genotype X environment interaction components of variance of each genotype into two parts. Therefore, each genotype is characterized by three parameters viz.; (A) mean yield (x) over all environments, (B) a linear regression coefficient (bi) in relation to environment index and (C) the deviation from linear regression (S^2di).

Since, the average slope for the environmental index is 1.0, regression coefficient for each genotype may be 1.0 or greater or lesser than 1.0. The

genotype with regression value of 1.0 is considered to have an average adaptability, whereas the value less than 1.0 or higher than 1.0 would mean below average and above average adaptability respectively. Another stability parameter S^2di indicates the variation displayed by the genotypes for a particular character over environments having similar indices. In this study, a genotype with unit regression coefficient (bi=1) and the deviation not significantly different from zero ($S^2di=0$) is considered to be stable as suggested by Singh and Chaudhary (1985).

Stability parameters were computed as method suggested by Eberhart and Russell (1966) as follow:

$$Y_{ij} = \mu + ß_i I_j + \delta_{ij}$$

I = varies from 1 to g,

J = varies from 1 to e,

Where,

Yij = mean of i^{th} genotype in j^{th} environment,

μ = mean of all genotypes over all environments,

$ß_i$ = regression coefficient of i^{th} genotype on the environmental index which measures the response of this genotype to the varying environments.

I_j = the environmental index which is defined as the deviation of the mean, of all the genotypes at a given location from the overall mean and

δ_{ij} = the deviation from regression of the i^{th} genotype at j^{th} environment.

ANOVA for stability analysis:

Source	DF	Sum of Square	Mean Square
Total	(ge-1)	$\Sigma_i\Sigma_j Y^2_{ij} - CF$	
Genotypes	(g-1)	$1/e\ \Sigma_i Y^2_i - CF$	MS1
Environment + (G x E)	g (e-1)	$\Sigma_i\Sigma_j Y^2_{ij} - \Sigma_i Y^2_i/e$	
Environment (linear)	1	$1/g\ [\Sigma_j Y_{ij} I_j]^2/\Sigma_j I_j^2$	
Genotype x Environment (linear)	(g-1)	$\Sigma_j[C\Sigma_j Y_{ij} I_j]^2/\Sigma_j I_j^2$	MS2
Pooled deviation	g (e-2)	$\Sigma_i\Sigma_j S_{ij}^2$	MS3
Pooled error	eg(r-1)	S^2e	

Where,

$[\Sigma_j Y_{ij} I_j^2/\Sigma_j I_j^2]$ = Variance due to regression,

S^2e = The estimate of pooled error,

e = Number of environments,

g = Number of genotypes,

r = Number of replications.

Estimation of stability parameters

The regression coefficient (bi) and mean square deviation from the linear regression (S^2di) were estimated as follows:

Computation of regression coefficient (bi)

The regression coefficient, which is the regression of the performance of each genotype under different environment on the environmental means, was estimated as follows:

bi = $\Sigma_j Y_{ij} I_j/\Sigma_j I_j^2$

Where, $Y_{ij} I_j$ = sum of products of environmental index (I_j) with corresponding mean of that genotype in each environment (Y_{ij}).

$\Sigma_j I_j^2$ = sum of squares of the environmental index (I_j).

a) for each value of regression coefficient I_j is common and equal to

$S_j I_j^2 = I_1^2 + I_2^2 + \text{------} + I_i^2 + \text{----------} + I_g^2$

b) On the other hand, $Y_{ij}I_j$ for each genotype is the sum of products of environmental index (I_j) with the corresponding mean of that genotype in each environment.

These values may be obtained in the following manner.

$[X] \times [I_j] = [\Sigma_j Y_{ij} I_j] = [S]$

where [X] = matrix of means

$[I_j]$ = vector of environmental index

[S] = vector of sum of products i.e., $Y_{ij}I_j$

Tests of significance

The following tests of significance were carried out:

i) To test the significance of differences among genotype means,

$H_0 = \mu_1 = \mu_2 = \ldots\ldots\ldots\ldots\ldots = \mu_g$

The 'F' test used was

$$F = \frac{\text{Mean squares due to genotypes}}{\text{Mean squares due to pooled deviation}} = \frac{MS1}{MS3}$$

ii) To test that the genotypes did not differ due to regression on environmental index i.e.,

$H_0 = \bar{b}_1 = \bar{b}_2 = \ldots\ldots\ldots = b_g$

The 'F' test used was

$$F = \frac{\text{Mean squares due to G X E (linear)}}{\text{Mean square due to pooled deviation}} = \frac{MS2}{MS3}$$

iii) Individual deviation from linear regression was tested as follows:

$F = [\Sigma_j S_{ij}^2/e-2]$/pooled error - t value at 5% level].

$P = 0.05$ at (g-2) df.

iv) The hypothesis that any regression coefficient did not differ from unity or from zero was tested by the appropriate 't' test i.e.

For $t = 1-b/Se\,(b)$ $P = < 0.05$ for (g-2) df

$Se\,(bi) = \sqrt{[\Sigma_j S_{ij}^2]/e-2/\Sigma_j I^2}$

Stable genotype

A genotype with unit regression coefficient (bi=1) and the deviation not significantly differing from zero ($S^2di=0$) was taken to be stable genotype with unit response.

$$\text{Mean standard error of bi} = \frac{bi - 0}{Se\,(bi)}$$

Mean of bi = $\Sigma i\ bi/g$

Se (bi) = $\sqrt{}$ MS due to pooled deviation / $\Sigma\, j\, I\, j^2$ Population mean (μ) and standard error were calculated as:

$$\text{Populations mean } (\mu) = \frac{\text{Grand total}}{\text{Total no. of observations}}$$

$$\text{SE (Mean)} = \frac{\sqrt{\text{Mean squares due to pooled deviation}}}{\text{No. of envrironments-1}}$$

Chapter - IV
Results

RESULTS

The present investigation was undertaken to evaluate the performance of one hundred and one accessions of maize (*Zea mays L.*) for various fodder, seed yield and quality characters. Data on fodder and seed yield and their contributing characters along with quality traits of the fodder were analyzed to estimate genetic variability/diversity, character associations, gene x environment interaction and stability over different environments. The experimental findings are presented under following sections:

4.1 Variability.
4.2 Genetic divergence / Genetic diversity.
4.3 Character association / Genetic relationship.
4.4 Gene x Environment interaction and phenotypic stability.

4.1 Variability

4.1.1 Qualitative traits

Visual observations were recorded for fodder and seed traits separately and one hundred and one accessions including African Tall were grouped into various frequency classes. (Table 4.1)

i) Leaf blade colour

Eighty five accessions had dark green leaf blade colour while, 16 accessions showed light green leaf blade colour.

ii) Sheath colour

Among sheath colour variability, 69 accessions had dark green sheath and 32 were having light green sheath.

iii) **Midrib colour**

There was no variation in Midrib colour as all accessions possessed white midrib.

iv) **Stem colour**

Thirty four accessions had dark green stem colour while 67 showed light green stem.

v) **Kernel (seed) colour**

There was wide variation in kernel colour. 22 accessions had dark yellow kernels, 49 light yellow, 14 white, 8 variegated, 1 brown and 7 accessions had yellow kernels.

vi) **Kernel row arrangement**

There was also substantial variation among the Kernel row arrangement in the ears of maize accessions. 53 accessions showed regular arrangement, 27 straight, 15 irregular and only six accessions showed spiral row arrangement.

vii) **Kernel shape**

Eighty three accessions had shrunken kernels, 15 round, 7 indented while only one accession showed pointed kernels.

viii) **Kernel size**

Seventeen accessions showed small kernel size, 53 medium and 31 accessions showed bold kernels.

ix) **Cob shape**

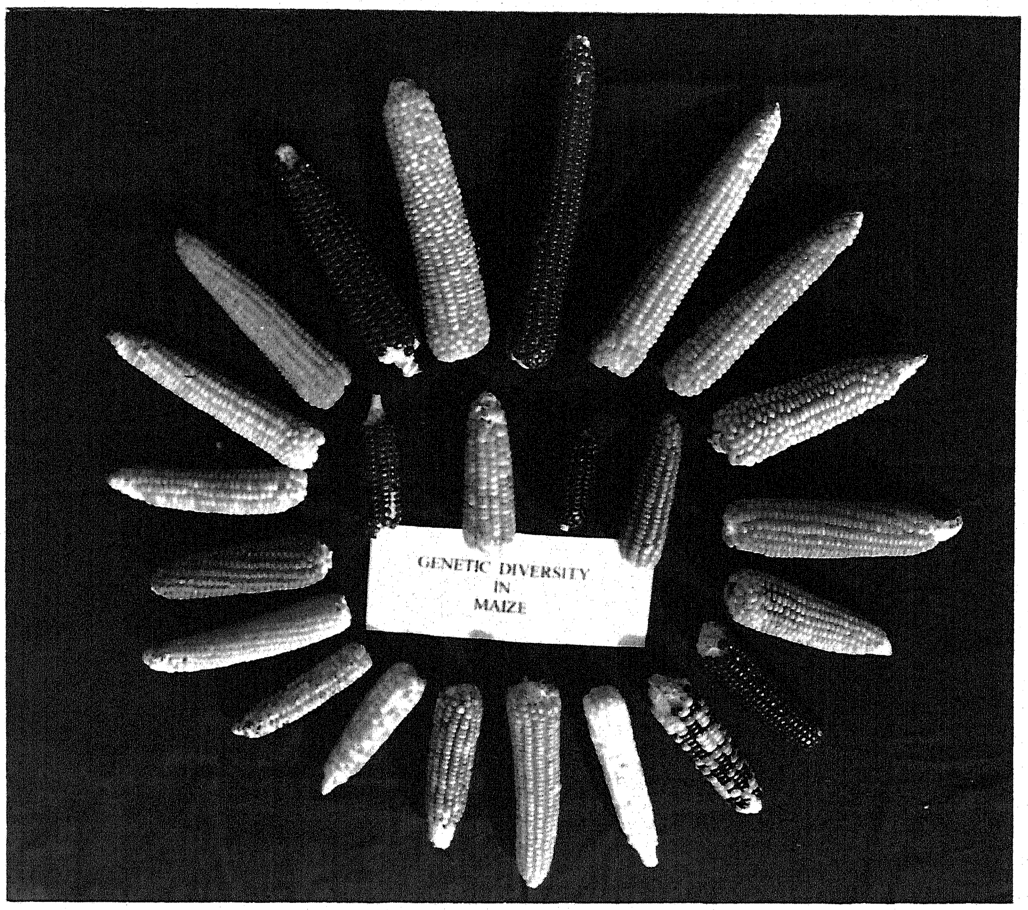
Fifty three accessions had cylindrical cob shape while 48 showed conical shape.

Quantitative traits

On the basis of mean performance of each character, five major groups were formed for fodder and seed yield traits separately (Table 4.2 and 4.3). This grouping indicated that maximum accessions were placed in group II and III. For green fodder yield/plant (g), maximum accessions were placed in group II having 76 accessions and group V had only one genotype namely African Tall having maximum green fodder yield/plant. For dry fodder yield group III was the largest having 52 accessions and group V were having only

Table 4.1 Frequency distribution of qualitative traits.

S. No.	Characters	Group - 1	Group - 2	Group - 3	Group - 4	Group - 5	Group - 6
1	**Leaf blade colour**	Dark green (85)	Light green (16)	-	-	-	-
2	**Sheath colour**	Dark green (69)	Light green (32)	-	-	-	-
3	**Midrib colour**	White (101)	-	-	-	-	-
4	**Stem colour**	Dark green (34)	Light green (67)	-	-	-	-
5	**Kernel colour**	Dark yellow (22)	Light yellow (49)	White (14)	Variegated (8)	Brown (1)	Yellow (7)
6	**Kernel row arrangement**	Regular (53)	Straight (27)	Irregular (15)	Spiral (6)	-	-
7	**Kernel shape**	Shrunken (83)	Round (15)	Indented (2)	Pointed (1)	-	-
8	**Kernel size**	Small (17)	Medium (53)	Bold (17)	-	-	-
9	**Cob shape**	Cylindrical (53)	Conical (48)	-	-	-	-



Ⓐ Shape, size & colour variation in maize cobs

Ⓑ Shape, size & colour variation in maize kernels

PLATE-1

one genotype namely African Tall. For leaf-stem ratio group III was largest with 44 accessions and the maximum leafy part was reported for group V having three accessions namely IC-335068, IC-334889, and IC-335131. With regards the quality aspect mainly for crude protein content (%) group III was largest with 48 accessions and 11 accessions was rich in crude protein content. For days to maturity maximum accessions were found in group I having 49 accessions and group V had only one genotype namely African Tall were late in maturity. For test weight group III was largest having 39 accessions and maximum values for this trait was reported in group V having only 5 accessions with African Tall namely IC-334853, IC-334869, IC-334932, IC-335024, IC-334954. For seed yield/plant, group II was largest with 42 accessions and maximum seed yield was reported for group V having 6 accessions with African Tall namely IC-335024, IC-335116, IC-335094, IC-334974, IC-335122, IC-334999.

Analysis of variance was separately computed for eleven fodder yield and twelve seed yield contributing traits. The characters which were evaluated for fodder traits are days to 50% silking, plant height, number of leaves/plant, leaf blade length, sheath length, leaf width, stem girth, green fodder yield/plant, dry fodder yield/plant, leaf - stem ratio and crude protein content whereas, characters like days to 50% silking, day to maturity, plant height, cob length, number of kernel rows, number of kernels/row, shank diameter, kernel length, kernel width, 100-seed weight (test weight) and seed yield/plant were measured for seed yield and their contributing traits. The mean sum of square (ms) with appropriate degree of freedom (df) for individual environment for the fodder and seed yield characters are presented in Table 4.4 and 4.5, respectively. Similarly mean sum of square (ms) under each source of variation for pooled analysis of fodder and seed traits are given in Table 4.6 and 4.7.

The analysis of variance recorded highly significant "F" values for all the characters under investigation in each separate environment and on the pooled basis for fodder traits. Analysis of variance showed highly significant values for all the traits except for genotype and gene x environment

Table 4.2 Frequency distribution of fodder yielding traits.

Characters	Group - 1	Group - 2	Group – 3	Group - 4	Group - 5
Days to 50% silking	43 - 59.22 (43)	46.25 - 49.49 (24)	49.50 - 52.74 (27)	52.75 - 55.99 (06)	56 - 59.59.29 (01)
Plant height (cm)	148.44 - 172.53 (14)	172.54 - 196.63 (56)	196.64 - 220.73 (27)	220.74 - 224.83 (03)	244.84 - 268.93 (01)
No. of leaves/ plant	9.81 - 11.34 (25)	11.35 -12.88 (60)	12.89 - 14.42 (15)	14.43 -15.96 (-)	15.97 - 17.44 (01)
Leaf blade length (cm)	65.67 - 73.50 (02)	73.51 - 81.34 (18)	81.35 - 89.18 (54)	89.19 - 97.02 (21)	97.03 -104.81 (06)
Sheath length (cm)	13.09 - 14.58 (03)	14.59 - 16.08 (27)	16.09 - 17.58 (49)	17.59 - 19.08 (19)	19.09 - 20.54 (03)
Leaf width (cm)	6.44 - 7.21 (04)	7.22 - 7.99 (25)	8.0 - 8.77 (49)	8.78 - 9.55 (18)	9.56 - 10.33 (05)
Stem girth (cm)	1.54 - 1.82 (11)	1.83 - 2.11 (51)	2.12 - 2.40 (38)	2.41 - 2.69 (-)	2.70 - 2.94 (01)
Green fodder yield/plant (g)	208.83 - 447.9 (14)	448 - 687.07 (76)	687.08 - 926.15 (10)	926.16 - 1165.23 (-)	1165.24 - 1404.17 (01)
Dry fodder yield/plant (g)	41.57 - 67.31 (06)	67.32 - 93.06 (38)	93.07 - 118.81 (52)	118.82 - 144.56 (04)	144.57 - 170.29 (01)
Leaf - Stem ratio	0.23 - 0.30 (08)	0.31 - 0.98 (38)	0.39 - 0.46 (44)	0.47 - 0.54 (08)	0.55 - 0.62 (03)
Crude protein (%)	8.66 - 9.37 (02)	9.38 - 10.09 (06)	10.10 - 10.81 (48)	10.82 - 11.53 (34)	11.54 - 12.24 (11)

Table 4.3 Frequency distribution of seed yielding traits.

Characters	Group - 1	Group - 2	Group – 3	Group - 4	Group - 5
Days to maturity	70.00 – 79.86 (49)	79.87 – 89.73 (39)	89.74 – 99.66 (12)	99.67 – 109.56 (-)	109.57 – 119.33 (01)
Ear length (cm)	11.87 – 13.76 (17)	13.77 – 15.66 (34)	15.67 – 17.56 (38)	17.57 – 19.46 (10)	19.47 – 21.34 (02)
Ear width (cm)	3.06 – 3.22 (09)	3.23 – 3.39 (23)	3.40 – 3.56 (37)	3.57 – 3.73 (24)	3.74 – 3.90 (07)
No. of kernel rows	10.00 - 10.95 (03)	10.96 – 11.91 (29)	11.92 – 12.87 (41)	12.88 – 13.83 (23)	13.84 – 14.74 (05)
No. of kernels/ row	19.59 – 23.75 (10)	23.76 – 27.92 (21)	27.93 – 32.09 (31)	32.10 – 36.26 (22)	36.27 – 40.42 (17)
Shank diameter (cm)	0.98 – 1.11 (13)	1.12 – 1.25 (37)	1.26 – 1.39 (39)	1.40 – 1.53 (10)	1.54 – 1.62 (02)
Kernel length (cm)	0.75 - 0.80 (11)	0.81 – 0.85 (41)	0.87- 0.92 (33)	0.93 – 0.98 (13)	0.99 – 1.02 (03)
Kernel width (cm)	0.74 – 0.79 25	0.80 – 0.85 42	0.86 – 0.91 28	0.92 – 0.97 05	0.98 – 1.03 01
Test weight (g)	14.53 – 16.77 (08)	16.78 – 19.02 (30)	19.03 – 21.27 (39)	21.28 – 23.52 (18)	23.53 – 25.73 (06)
Seed yield/ plant (g)	126.21 – 153.29 (13)	153.30 – 190.38 (42)	180.39 – 207.47 (17)	207.48 – 234.56 (22)	234.57 – 261.61 (07)

Table 4.4 Analysis of variance showing mean sum of square for the various fodder traits.

Source	Env.	Year	d. f.	Days to 50% silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Green fodder yield/plant (g)	Dry fodder yield/plant (g)	Leaf - Stem ratio	Crude protein (%)
Replication	1	2001	2	3.248	0.355	0.125	31.765	4.216	1.066	0.069	923.020	59.849	0.008	0.308
	2	2002	2	17.178	640.699	1.412	36.710	0.405	0.506	0.251	39560.343	1396.529	0.007	3.543
	3	2003	2	5.708	109.451	0.236	71.823	2.584	1.000	0.178	459.507	29.290	0.012	0.172
Genotypes	1	2001	100	25.321**	1955.765**	4.686**	247.828**	11.232**	2.234**	0.225**	118477.640**	3146.029**	0.056**	3.800**
	2	2002	100	105.350**	1654.549**	5.555**	262.480**	10.014**	3.781**	0.266**	90211.607**	1813.960**	0.037**	1.338**
	3	2003	100	27.265**	1595.933**	4.710**	170.784**	4.840**	2.599**	0.181**	79061.379**	1600.800**	0.023**	2.523**
Error	1	2001	200	2.621	357.999	0.908	64.858	4.986	1.146	0.069	709.551	93.544	0.003	0.422
	2	2002	200	7.095	354.710	1.058	65.710	2.557	1.039	0.057	1598.167	92.260	0.005	0.458
	3	2003	200	6.940	228.474	0.738	52.262	1.964	0.771	0.770	944.947	65.409	0.006	0.301
CV	1	2001		3.792	8.953	7.548	9.112	12.663	1.239	13.260	4.0163	8.577	13.262	5.868
	2	2002		5.282	10.244	8.880	9.822	9.791	12.611	12.046	7.942	11.042	22.166	6.335
	3	2003		5.193	8.621	7.383	8.108	8.594	10.477	40.438	5.874	10.031	1.336	5.213
CD	1	2001		2.174	25.413	1.280	10.817	2.999	1.438	0.353	35.778	12.991	0.075	0.872
	2	2002		3.578	25.296	1.382	10.888	2.148	1.369	0.321	53.695	12.901	0.091	0.091
	3	2003		3.538	20.302	1.155	9.710	1.882	1.179	0.372	41.288	10.863	0.100	0.737

****Significant at 1% level**

Table 4.5 **Analysis of variance showing mean sum of square for the various seed traits.**

Source	Env.	Year	d. f.	Days to 50% Silking	Days to maturity	Plant height (cm)	Cob length (cm)	Cob width (cm)	No. of kernel row	No. of kernels/ row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	Test weight (g)	Seed yield /plant (g)
Replication	1	2001	2	3.248	36.213	0.355	56.273	0.149	0.114	487.585	0.221	0.001	0.004	1.306	849.918
	2	2002	2	17.178	6.571	640.699	17.027	0.544	0.385	398.056	0.165	0.019	0.026	3.359	1875.956
	3	2003	2	5.708	125.603	109.451	53.917	0.286	4.172	638.630	0.016	0.003	0.003	1.919	1006.814
Genotypes	1	2001	100	25.321**	402.533**	1955.765**	19.471**	0.269**	5.572**	123.841**	0.102**	0.018**	0.018**	25.178**	5516.163**
	2	2002	100	105.350**	112.712**	1654.549**	13.775**	0.214**	4.017**	128.896**	0.107**	0.023**	0.018**	35.176**	6642.986**
	3	2003	100	27.265**	167.928**	1595.933**	20.436**	0.366**	5.333**	172.335**	0.092**	0.024**	0.018**	51.612**	6046.467**
Error	1	2001	200	2.621	9.275	357.999	4.717	0.092	2.175	37.464	0.058	0.005	0.007	2.242	407.373
	2	2002	200	7.095	6.088	354.710	3.655	0.081	2.198	24.429	0.049	0.008	0.007	3.799	597.706
	3	2003	200	6.940	14.454	228.474	2.627	0.072	1.594	27.027	0.049	0.006	0.006	2.828	336.884
CV	1	2001		3.792	3.763	8.953	13.763	8.348	11.422	21.424	18.767	7.994	9.821	6.990	10.960
	2	2002		5.282	3.147	10.244	12.255	8.556	12.565	15.431	18.171	10.500	10.347	10.968	13.582
	3	2003		5.193	4.444	8.621	10.259	7.722	10.215	16.625	17.800	6.634	9.745	8.163	9.693
CD	1	2001		2.174	4.090	25.413	2.917	0.407	1.981	8.221	0.323	0.097	0.111	2.011	23.810
	2	2002		3.578	3.315	25.296	2.568	1.336	1.992	6.639	0.298	0.118	0.115	2.617	32.837
	3	2003		3.538	5.106	20.302	2.177	0.360	1.696	6.983	0.298	0.101	0.108	2.259	24.652

****Significant at 1% level**

Table 4.6 **Analysis of variance showing mean sum of square of the pooled data of fodder yield characters over environments**

Source	d.f.	Days to 50% Silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Green fodder yield/plant (g)	Dry fodder yield/plant (g)	Leaf- Stem ratio	Crude protein (%)
Replication	2	12.188	479.000	0.492	97.250	2.383	1.209	0.197	16144.000	605.750	0.005	0.879
Genotypes	100	93.093**	2867.102**	9.650**	339.831**	12.929**	4.471**	0.331**	170098.320**	2829.652**	0.040	3.540**
Environ.	2	6295.875**	107297.000**	104.340**	3981.750**	174.602**	23.594**	3.580**	2299280.000**	87776.250**	1.356**	24.391**
G X E	200	32.422**	1169.559**	2.650**	170.627**	6.578**	2.072**	0.171**	58826.360**	1865.563**	0.038	2.061**
Error	600	5.552	313.727	0.902	60.944	3.169	0.985	0.068	1084.222	83.738	0.004	0.393
C. V.		4.914	9.313	7.948	9.004	10.624	11.861	12.735	5.846	9.791	16.958	5.830
C. D.		1.827	13.734	0.736	6.053	1.381	0.770	0.202	25.538	7.096	0.052	0.486

**** Significant at 1% level**

Table 4.7 **Analysis of variance showing mean sum of square of the pooled data of seed yields characters over environments.**

Source	df	Days to 50% Silking	Days to maturity	Plant height (cm)	Cob length (cm)	Cob width (cm)	No. of kernel rows	No. of kernels/ row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	Test weight (g)	Seed yield/ plant (g)
Repl.	2	12.188	56.500	479.000	118.852	0.917	2.844	1459.906	0.287	0.012	0.018	3.531	2965.000
Genotypes	100	93.093**	467.702**	2867.102**	26.944**	0.290**	7.374**	231.065**	0.132**	0.029**	0.023**	46.050**	8098.587**
Env.	2	6295.875**	4000.750**	107297.000**	3.656	6.730**	92.188**	1001.175**	0.245**	0.294**	0.011**	1114.516**	6655.000**
G x E	200	32.422**	107.715**	1169.559**	13.369**	0.279**	3.775**	97.003**	0.084**	0.018**	0.015**	32.958**	5053.450**
Error	600	5.552	9.946	313.727	3.666	0.082	1.989	29.641	0.052	0.006	0.007	2.956	447.336
CV		4.914	3.864	9.313	12.175	8.217	11.411	17.779	18.231	9.085	9.934	8.626	11.463
C D		1.827	2.446	13.734	1.485	0.222	1.094	4.221	0.177	0.061	0.064	1.333	16.401

**** Significant at 1% level**

interaction with respect to leaf-stem ratio and stem girth. Similarly, for seed traits, analysis of variance showed highly significant values except for the ear length.

The significant "F" values for all the characters under study in individual environment as well as in pooled analysis indicated appreciable variability among the accessions. Highly significant values of mean sum of square of the genotype x environment interaction on pooled analysis of variance over environments indicated appreciable influence of environment in genotypes. Variability parameters were studied for fodder and seed yield traits separately.

Fodder Yield Characters

The estimation of the range and mean of the various fodder yielding characters are presented in Table 4.8. A wide range of phenotypic variability was observed for all the characters studied. Results showed that the highest variation was found in green fodder yield/plant, whereas low variation within the ranges was observed for crude protein content (%). The details of the range and mean of each character on pooled basis over three environments are given below:

i) **Days to 50% silking**

On pooled basis, days to 50% silking showed a range of 43 to 59 days with the general mean value of 47 days. The accessions IC-335056 and IC-334973 were considered to be of early silking type while African Tall and IC-334833 were found to be of late silking type over three environments.

ii) **Plant height (cm)**

Plant height exhibited mean value ranging between 140.44 to 260.93 cm and overall mean was 190.17 cm. African Tall followed by IC-334855 exhibited the maximum plant height. Lowest plant height was observed in IC-335060 and IC-335056.

iii) **Number of leaves/plant**

A count of leaves per plant showed wide variation within range from 9.81 to 17.44 with the overall mean of 11.95 leaves/plant. It is evident from the result that African Tall possessed maximum number of leaves

(17.44) followed by IC-335035 (13.63). Lowest number of leaves was found for the accession IC-335086 (9.81) followed by IC-335068 (9.89).

iv) Leaf blade length (cm)

On pooled basis over three environments the range of leaf blade length was observed between 65.67 to 104.81 cm and the overall average value was recorded as 86.69 cm. Over three environments African Tall (104.81) exhibited maximum leaf blade length followed by IC-334999 (99.00). Narrower blade length was observed for the accession IC-335069 (65.67) followed by IC-335060 (72.93).

v) Sheath length (cm)

Sheath length exhibited variation from 13.09 to 20.54 with mean value of 16.76. Maximum sheath length was exhibited by African Tall (20.54) followed by IC-334833 (19.49), whereas minimum sheath length was observed in IC-335060 (13.09) and IC-335068 (14.01).

vi) Leaf width (cm)

Leaf width showed variation ranging from 6.44 to 10.32 cm with mean value 8.37 cm. IC-334932 showed the maximum leaf width (10.32) followed by accession IC-334846 (10.21). Narrow leaf width was observed for IC-335060 (6.44) and IC-334989 (6.70).

vii) Stem girth (cm)

The range of variation in stem thickness was from 1.54 to 2.94 and the general average value was 2.04. Maximum stem thickness was found in African Tall followed by IC-334848 (2.37) and thinnest stem was observed in the accession IC-335068 (1.54) followed by IC-335060 (1.71).

viii) Green fodder yield/plant (g)

As fresh vegetative parts of the plant contribute to maximum green fodder yield, therefore this character showed high degree of variation ranging from 208.83 to 1404.17 g and the mean green fodder yield was 563.31 g/plant. The strains namely African Tall and IC-334846 exhibited highest green fodder yield. The low fodder yielding accessions were IC-335068 and IC-335060.

ix) **Dry fodder yield/plant (g)**

Genetic lines under study showed wide variation for dry fodder yield ranging from 41.57-170.29 (g) per plant with a mean value of 93.46 (g) per plant. The genetic lines exhibiting high dry matter were African Tall and IC-334833. The lowest dry matter containing accessions were IC-335068 and IC-335060.

x) **Leaf-Stem ratio**

On the basis of pooled data over three environments dry leaf-stem ratio ranged from 0.23 to 0.62 with general average value of 0.39. The accessions exhibiting high leafiness were IC-335068 and IC-334889. Low leaf-stem ratio was found in the accession IC-334825 followed by IC-334996.

xi) **Crude Protein content (%)**

Crude protein content (%) showed less variation ranging between 8.66 to 12.24 and overall mean value was 10.75. The accessions having high crude protein content were IC-334841 (12.24) and IC-334920 (12.12) while low crude protein content was observed in African Tall followed by IC-334871.

Seed Yield Characters

In addition to days to 50% silking and plant height, the following ten characters, which are the major components for seed yield, were also studied. The estimates of range and mean of all characters are presented in Table 4.9. Results showed wide range of variation for seed yield/plant and number of kernels/row. Among seed attributes, cob width exhibited minimum variation followed by number of kernel rows. Results in detail for each character are given below.

i) **Days to maturity**

On the basis of pooled data over three environments, days to maturity showed variation in the range of 70 to 119 days and the overall mean was 81 days. The accessions IC-335111 and IC-335069 are early maturing type as they matured in 70 days while late maturity was observed in African Tall (119 days) followed by IC-334904 (94 days).

Table 4.8 Variability parameters for fodder yield.

Characters	Range	Mean	PCV	GCV	h^2 (Broad sense)	Genetic advance (GA)	GA (%of mean)
Days to 50% silking	43.00 - 59.22	47.95	7.31	5.41	54.80	3.96	8.26
Plant height (cm)	148.44 -268.93	190.17	11.78	7.22	37.60	17.34	9.12
No. of leaves/ plant	9.81 – 17.44	11.95	10.85	7.38	46.30	1.24	10.38
Leaf blade length (cm)	65.67 – 104.81	86.69	10.30	5.00	23.60	4.34	5.01
Sheath length (cm)	13.09 – 20.54	16.76	11.75	5.01	18.20	0.74	4.42
Leaf width (cm)	6.44 – 10.32	8.37	13.37	6.17	21.30	0.49	5.85
Stem girth (cm)	1.54 – 2.94	2.04	14.31	6.52	20.80	0.13	6.37
Green fodder yield/ plant (g)	208.83 – 1404.17	563.31	20.59	19.74	91.90	219.62	38.99
Dry fodder yield/ plant (g)	41.57 – 170.29	93.46	14.78	11.07	56.10	15.97	17.09
Leaf - Stem ratio	0.23 – 0.62	0.39	17.28	3.32	3.70	0.01	2.56
Crude protein (%)	8.66 – 12.24	10.75	6.94	3.77	29.50	0.45	4.19

ii) **Cob length (cm)**

The cob length varied from 11.87 to 21.34 cm with the mean value of 15.73 cm. The accessions IC-334834 and IC-334904 exhibited less cob length as 11.87 and 12.03, respectively whereas African Tall (21.34) followed by IC-335024 (19.81) exhibited maximum cob length.

iii) **Cob width (cm)**

Cob width showed low variation ranging from 3.06 cm to 3.90 cm with the average mean of 3.48 cm. The accession IC-334932 and IC-334877 was exhibiting wide cobs while IC-334834 and IC-335149 showed narrow cob width.

iv) **Number of kernel rows**

The number of kernel rows/cob varied from 10.00 to 14.74 rows. The overall mean was 12.36 rows/cob over three environments. Maximum number of kernel rows/cob was exhibited by the accessions IC-334944 (14.74) and IC-334947 (14.48). The least number of kernel rows/cob were observed in the accessions IC-334867 (10.00) and IC-334833 (10.22).

v) **Number of kernels/row**

The number of kernels/row, which is expected to have direct effect on seed yield, showed a wide range of variation from 19.59 to 40.42 kernels/row with the general mean of 30.62 kernels/row. The result indicated that the accession IC-335094 (40.42) followed by IC-335120 (40.30) consisted of maximum kernels/row, whereas low count of kernels/row was observed in IC-334904 (19.59) and IC-334954 (20.37).

vi) **Shank diameter (cm)**

Shank diameter expected to have direct effect on seed yield, showed variability ranging from 0.98 cm to 1.62 cm and the general average was found to be 1.25 cm. Maize strains like African Tall followed by IC-334996 exhibited big shank size. Whereas accessions like IC-334947 and IC-334833 showed poor shank size.

vii) **Kernel length (cm)**

Kernel length exhibited mean value ranging from 0.75 to 1.02 cm. The pooled mean of this trait was 0.86 cm. The accessions like IC-334954 and IC-334853 were possessing longest kernels while IC-335086 and IC-335056 had shortest ones.

viii) **Kernel width (cm)**

Kernel width showed variation ranging from 0.74 to 0.99 cm. The pooled average width was 0.83 cm. Accessions like IC-334869 and IC-334846 showed more kernel width. Accessions IC-335086 and IC-335158 consisted of narrow kernel width.

ix) **Test Weight (g)**

The average weight of 100 seeds from each accessions varied from 14.53 g to 25.73 g with pooled mean of 19.93 g. Results indicated that the strains like African Tall (25.73) followed by IC-334853 (23.10) showed high test weight, whereas the low test weight was observed in IC-335086 (14.53g) and IC-335115 (15.54).

x) **Seed Yield/ Plant (g)**

The range of variation in seed yield/plant was very high showing a range from 126.21g to 261.61g/plant and the average seed yield was 184.51g/plant. The maximum seed yield was obtained from the germplasm lines African Tall (261.61) followed by IC-335024 (260.64).

Genotypic and Phenotypic Coefficients of Variation

The data on genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV) for various quantitative traits for fodder and seed yield and their component characters (on pooled basis) over three environments are presented in Table 4.8 and Table 4.9, respectively.

It is evident from Table 4.8 that the variability estimates in general, for forage relating traits reported that the phenotypic coefficients of variation was relatively higher than the corresponding genotypic coefficients of variance for different characters. The phenotypic coefficients of variation help in the measurement of the range of phenotypic diversity in a character and provide a means to compare the phenotypic variability in quantitative characters. It

ranged from 6.94 per cent to 20.59 per cent across the characters. The phenotypic coefficient of variation values were considerably high for characters like green fodder yield/plant (20.59), leaf - stem ratio (17.28), dry fodder yield/plant (14.78), stem girth (14.31) and leaf width (13.37). Moderate phenotypic coefficients of variation was observed for plant height (11.78) followed by sheath length (11.75), number of leaves/plant (10.85) and leaf blade length (10.30), whereas low values of phenotypic coefficients of variation were observed for crude protein percent (6.94) and days to 50% silking (7.31).

The genotypic coefficients of variation which gives a picture of the extent of genetic variability in the population, ranged from 3.32 to 19.74 per cent. The genotypic coefficients of variation values were considerably high for characters such as green fodder yield/plant (19.74). Moderate genotypic coefficients of variation were found in dry fodder yield/plant (11.07), whereas low values of genotypic coefficients of variation were observed in leaf - stem ratio (3.32), crude protein content (3.77), leaf blade length (5.00), sheath length (5.01), days to 50% silking (5.41), leaf width (6.17), stem girth (6.52), plant height (7.22) and number of leaves/plant (7.30).

Similarly, for seed traits in the present study (Table 4.9), in general phenotypic coefficients of variation values showed relatively high values than corresponding genotypic coefficients of variation for all the traits under study. The phenotypic coefficients of variation which gives a picture of the extent of phenotypic variability in the population, ranged from 7.31 to 21.79 per cent. The phenotypic coefficients of variation was considerably high for characters like number of kernels/row (21.79) followed by shank diameter (19.15), seed yield/plant (15.19) and cob length (14.46). Moderate phenotypic coefficients of variation (PCV) were observed in number of kernel rows (12.51) followed by plant height (11.78), 100- seed weight (10.54) and kernel width (10.51). Lower phenotypic coefficient of variation was recorded for days to 50% silking (7.31), cob width (8.28) and days to maturity (8.66).

Genotypic coefficients of variation for seed traits showed variability ranging from 0.98 to 12.60 per cent. Maximum genotypic coefficients of variation were found for number of kernels/row (12.60), whereas moderate

Table 4.9 Variability parameters for seed yield.

Character	Range	Mean	PCV	GCV	h^2 (Broad sense)	Genetic advance (GA)	GA (% of mean)
Days to 50% silking	43.00 - 59.22	47.95	7.31	5.41	54.80	3.96	8.26
Days to maturation	70.00 – 119.33	81.62	8.66	7.75	80.10	11.66	14.29
Plant height (cm)	148.44 -268.93	190.17	11.78	7.22	37.60	17.34	9.12
Cob length (cm)	11.87 – 21.34	15.73	14.46	7.81	29.10	1.37	8.71
Cob width (cm)	3.06 – 3.90	3.48	8.28	0.98	1.40	0.01	0.29
No. of kernel rows	10.00 – 14.74	12.36	12.51	5.12	16.70	0.53	4.29
No. of kernels/ row	19.59 – 40.42	30.62	21.79	12.60	33.40	4.60	15.02
Shank diameter (cm)	0.98 – 1.62	1.25	19.15	5.87	9.40	0.05	4.00
Kernel length (cm)	0.75 – 1.02	0.86	9.94	4.02	16.40	0.03	3.49
Kernel width (cm)	0.74 – 0.99	0.83	10.51	3.43	10.70	0.02	2.41
Test weight (g)	14.53 – 25.73	19.93	10.54	6.05	33.00	1.43	7.18
Seed yield/ plant (g)	126.21 –261.61	184.51	15.19	9.97	43.10	24.87	13.48

values were reported from seed yield/plant (9.97). Low values of genetic variability were observed in cob width (0.98) followed by kernel width (3.43), kernel length (4.02), number of kernel rows (5.12), days to 50% silking (5.41), shank diameter (5.87), 100 seed weight (6.05), plant height (7.22), days to maturity (7.75) and cob length (7.81).

Further, the differences between phenotypic coefficients of variation and genotypic coefficients of variation for most of the characters e.g. leaf - stem ratio, stem girth, leaf width, sheath length and leaf blade length was pronounced among fodder traits. Whereas for seed traits, shank diameter, number of kernels/row, cob width, cob length and kernel width were higher indicating a considerable influence of the environment on their expression. The characters such as green fodder yield/plant, days to 50% silking, dry fodder yield/plant, number of leaves/plant, crude protein content (%) and plant height among fodder traits whereas for seed traits, days to maturity, days to 50% silking, 100 seed weight, plant height, seed yield/plant, kernel length and number of kernel rows showed low variability indicating genetic nature of accessions playing a major role in expression of these characters. Leaf - stem ratio, crude protein content (%), cob width and kernel width were showing low genotypic variance indicating lesser variability for these characters.

Heritability

With the help of genotypic coefficients of variation alone, it is not possible to determine the amount of variation that is heritable. Heritability in broad sense, provide a good parameter for reliable estimation of genetic potential of a given population. The estimation of heritability (in broad sense) for fodder and seed yield and their component characters over the environments are given in Table 4.8 and 4.9.

Among fodder yielding traits, green fodder yield/plant, dry fodder yield/ plant and days to 50% silking showed considerably high values of heritability. The remaining characters under study exhibited low to medium level of heritability ranging between 3.70-46.30 per cent. The lowest value of heritability was exhibited by leaf - stem ratio.

Similarly, in case of seed yield and yield contributing characters, in general, days to maturity and days to 50% silking had high heritability values ranging from 54.80 to 80.10 percent. Whereas remaining characters like cob width, shank diameter, kernel width, kernel length, number of kernel rows, cob length, 100-seed weight, number of kernels/row, plant height, seed yield/plant showed very low to moderate level of heritability ranging between 1.40 to 43.10 per cent.

Genetic Advance

Expected genetic advance and its estimates as percentage of mean for various fodder characters (Table 4.8) revealed that green fodder yield/plant exhibited the highest expected genetic advance. The moderate values of genetic advance were observed in the characters such as plant height, dry fodder yield/plant. Relatively very low to low values of genetic advance, ranging between 2.56 to 5.01 per cent were recorded for the characters like, leaf - stem ratio, stem girth, crude protein content (%), leaf width, sheath length, number of leaves/plant, days to 50% silking and leaf blade length.

Among seed yield contributing traits (Table 4.9), maximum genetic advance was found in number of kernels/row, days to maturity and seed yield/plant indicating importance of genetic constitution in their expression. Moderate values were observed in plant height and 100-seed weight. The remaining traits like cob width, kernel width, kernel length, shank diameter and number of kernel rows were showing very low to low genetic advance ranging from 0.29-4.29 per cent.

4.2 Genetic Divergence

Genetic divergence is an essential requirement for any crop improvement programme because genetically diverse parents when crossed can bring together diversity of gene combinations either to exploit heterosis or to obtain superior recombinants. Therefore, an attempt was made to evaluate the magnitude of genetic divergence among one hundred and one germplasm lines of maize with the help of non-hierarchical Euclidean cluster analysis following Beale (1969) and Spark (1973).

The analysis of variance revealed significant differences within the maize accessions for all the traits studied. Based on non-hierarchical Euclidean cluster analysis, 101 cultivars were grouped into eight clusters for fodder as well as for seed traits in combined form. (Table 4.10)

Amongst eight clusters, Cluster III composed of 26 accessions was the largest group followed by cluster VII that included 19 accessions. Cluster VI composed of 16 accessions, whereas cluster I was made up of 15 accessions. Cluster II and VIII included 12 and 10 accessions respectively. Cluster V and IV were considered as digenotypic and monogenotypic, respectively.

It was interesting to note that the accessions belonging from same eco-geographical regions were scattered over different clusters. This indicated that there is substantial genetic diversity between the accessions. On the other hand, many accessions originating from one place were included in same cluster.

From the perusal of the table 4.11, the average intra cluster divergence was zero for all possible pairs of combinations. The average inter cluster distance values ranged from 2.82 to 20.97. For all the characters maximum inter cluster distance was observed between cluster IV and V (20.97) followed by I to IV, III to IV, IV to VII IV to VI and II to IV. Cluster IV was more divergent to each cluster.

The minimum inter cluster divergence was observed between cluster III and VII (2.82) followed by I to III, VII to VIII, VI to VIII and III to IV. The distribution pattern of clustering revealed considerable diversity among accessions. The use of accessions in hybridization from these groups having most of the desirable characters is likely to produce more transgressive segregants.

The clusters mean values for all the traits are presented in Table 4.12. There was wide range of variation in the cluster mean values for all the characters under study. The genotype belonging to cluster IV had the highest dry fodder yield as well as seed yield, whereas it was low for cluster V and cluster II, respectively. Days to 50% silking and maturity were found short for clusters V while they were prolonged for cluster IV. The genotypes belonging to cluster IV had taller plants, long leaf blade length and sheath length, wide

Table 4.10 Composition of clusters for various fodder and seed yield characters over three environments.

Cluster No.	Number of accessions	Accession number/ name
I	15	IC-334821, 334889, 334904, 334920, 334947, 334989, 335051, 335056, 335062, 335069, 335079, 335082, 335086, 335144 and 335169.
II	12	IC- 334830, 334833, 334834, 334837, 334846, 334855, 334872, 334879, 334881, 334915, 334945 and 334949
III	26	IC - 334826, 334955, 334973, 335028, 335045, 335053, 335089, 335098, 335103, 335109, 335110, 335111, 335112, 335115, 335120, 335128, 335131, 335138, 335141, 335149, 335156, 335158, 335164, 335173, 335178 and 335184.
IV	1	African Tall
V	2	IC - 335060, 335068.
VI	16	IC - 334836, 334838, 334841, 334853, 334863, 334864, 334867, 334869, 334871, 334876, 334877, 334880, 334884, 334943, 334954 and 334957.
VII	19	IC - 334825, 334974, 334996, 334999, 335000, 335009, 335017, 335024, 335025, 335043, 335048, 335050, 335092, 335094, 335116, 335117, 335122, 335128 and 335152.
VIII	10	IC - 334842, 334848, 334929, 334932, 334942, 334944, 335027, 335032, 335035 and 335041.

Table 4.11 Distance between cluster centroids among eight clusters.

Cluster No.	I	II	III	IV	V	VI	VII	VIII
I	0.000							
II	6.098	0.000						
III	3.007	4.716	0.000					
IV	17.443	13.167	15.261	0.000				
V	4.739	10.302	7.322	20.971	0.000			
VI	5.508	3.176	4.490	13.357	9.349	0.000		
VII	4.589	5.437	2.824	14.227	8.402	4.094	0.000	
VIII	5.231	4.474	4.065	12.951	8.853	3.168	3.156	0.000

Table: 4.12 Cluster means for different fodder and seed yield characters.

Clusters	Days to 50% Silking	Plant height (cm)	No. of leaves/plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Dry Fodder Yield/plant (g)	Leaf-Stem ratio	Crude Protein (%)	Days to maturity	Cob length (cm)	Cob width (cm)	No. of kernel rows	Kernels/row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	Test weight (g)	Seed yield/plant (g)
I	45.87	169.49	11.06	80.68	15.52	7.71	1.88	75.50	0.42	11.12	78.44	14.64	3.43	12.76	29.05	1.18	0.81	0.80	18.17	165.54
II	51.18	207.82	12.67	93.82	18.30	9.05	2.20	110.87	0.38	10.53	88.48	13.76	3.36	11.76	25.30	1.14	0.86	0.82	20.12	158.87
III	46.11	188.00	11.58	86.72	16.72	8.32	1.99	89.21	0.40	10.60	77.45	16.51	3.36	12.23	33.88	1.26	0.83	0.81	18.16	178.75
IV	59.22	268.93	17.44	104.81	20.54	10.21	2.94	170.29	0.47	8.66	119.33	21.34	3.71	13.17	39.26	1.62	0.94	0.90	25.73	261.61
V	45.11	152.87	10.04	69.30	13.55	6.96	1.54	44.74	0.54	11.10	73.00	12.76	3.51	13.91	26.67	1.22	0.83	0.78	17.09	165.17
VI	51.44	195.35	12.54	87.90	17.21	8.54	2.15	94.05	0.40	10.78	87.46	15.05	3.50	11.63	26.14	1.19	0.92	0.89	22.52	186.52
VII	45.80	190.58	11.65	87.60	16.47	8.22	2.03	99.26	0.35	10.78	78.11	16.99	3.60	12.41	33.95	1.38	0.88	0.86	20.72	214.61
VIII	49.94	196.18	12.81	85.11	16.93	8.78	2.14	100.63	0.40	10.93	84.32	16.41	3.69	13.48	31.68	1.26	0.93	0.83	21.32	194.42

leaf width and thick stem whereas all these characters were low for cluster V. Cluster IV showed highest values for leaf-stem ratio whereas it had low crude protein content while leaf-stem ratio was low for cluster VII and crude protein percent were higher for cluster I.

Late maturity promoted cob length, cob width, number of kernels/row, shank diameter, kernel length, kernel width and 100- seed weight, which were recorded in cluster IV. Kernel rows/cob had maximum values for Cluster V and low for cluster IV. Minimum values of cluster mean for cob width, number of kernels/row and shank diameter was found in cluster II. Kernel width was highest for cluster IV and lower for cluster I. The genotype belonging to cluster IV had maximum kernel width and 100- seed weight, whereas it was low for cluster V.

4.2.1 Analysis of genetic divergence using isozymes

Of the three isozymes used for the assay, maximum polymorphism was observed for esterase and peroxidase isozymes that exhibited 10 polymorphic bands (Table 4.13). While 13 distinct electrophoretic phenotypes (EPs) were noted in case of esterases, only 10 were recorded in peroxidases. SOD showed only four bands of which only one was polymorphic and only two kinds of EPs were observed.

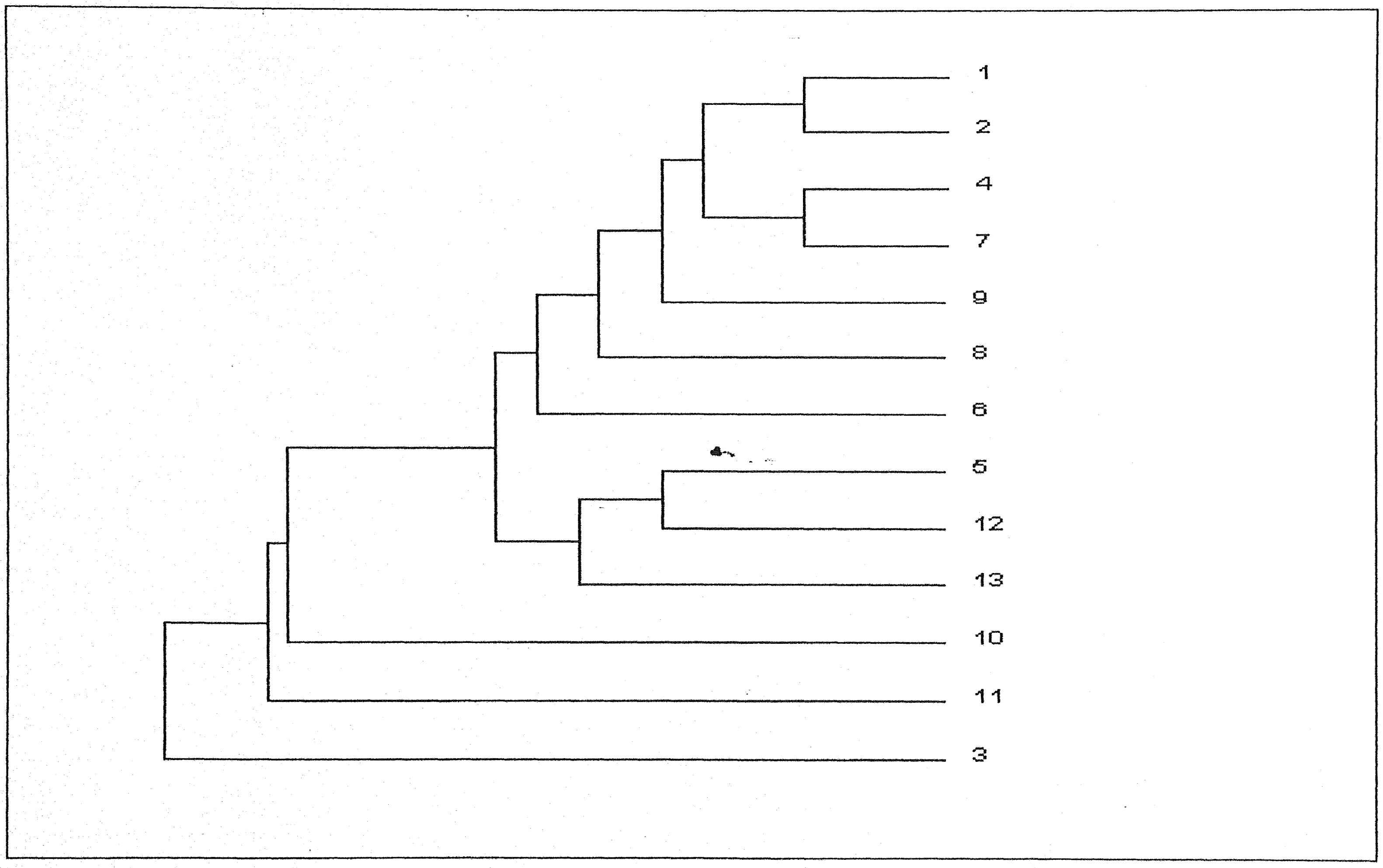
A perusal of the similarity indices based on the isozyme polymorphism revealed that the similarity varied from as low as 50% (0.5) between IC 334879 (Sirohi, Rajasthan; cluster II) and the accessions IC 334945 (Ujjain, MP; cluster II) or IC 335053 (Hardoi, UP; cluster III) to as high as 0.929 between IC 334836 (Rajsamand, Raj; cluster VI) and IC 334954 (Jhalawar, Raj; cluster VI) or between IC 334915 (Banswara, Raj; cluster II) and IC 335111 (Kannauj, UP; cluster III).

UPGMA based dendrogram indicated that there was no relationship among geographical, agronomic and isozyme diversity. However, generally, accessions from the same state tend to be together. Exceptionally in one case, two accessions from the same location (IC 334836 and IC 334853; both from Rajsamand, Raj) were relatively far apart (Fig 4.1).

Table 4.13 **Similarity (simple matching coefficient) among 13 diverse accessions of maize based on the esterase, super oxide desmutase and peroxidase isozyme profile**

S. No.	Accessions No.	1	2	3	4	5	6	7	8	9	10	11	12	13
1	IC- 334836	**1.000**	0.929	0.750	0.893	0.857	0.786	0.893	0.821	0.893	0.607	0.679	0.786	0.786
2	IC- 334954		**1.000**	0.679	0.821	0.786	0.714	0.893	0.821	0.821	0.607	0.679	0.714	0.714
3	IC- 334879			**1.000**	0.714	0.607	0.607	0.714	0.571	0.643	0.500	0.500	0.536	0.607
4	IC- 334515				**1.000**	0.821	0.893	0.929	0.857	0.857	0.714	0.571	0.750	0.750
5	IC- 335017					**1.000**	0.786	0.821	0.821	0.821	0.607	0.679	0.857	0.786
6	African Tall						**1.000**	0.821	0.821	0.750	0.679	0.536	0.786	0.714
7	IC- 335111							**1.000**	0.857	0.857	0.643	0.643	0.750	0.750
8	IC- 335173								**1.000**	0.786	0.714	0.643	0.821	0.679
9	IC- 334853									**1.000**	0.714	0.714	0.821	0.821
10	IC- 334945										**1.000**	0.643	0.750	0.750
11	IC- 335053											**1.000**	0.750	0.821
12	IC- 335069												**1.000**	0.857
13	IC- 334929													**1.000**

Fig 4.1 UPGMA dendrogram depicting similarity among 13 diverse accessions of fodder maize.



Explanation of Plate	
Isozymes diversity among 13 accessions of fodder maize	
A.	**Esterase diversity among 13 accessions of fodder maize**
B.	**Peroxidase diversity among 13 accessions of fodder maize**
C.	**Superoxide desmutase diversity among 13 accessions of fodder maize**

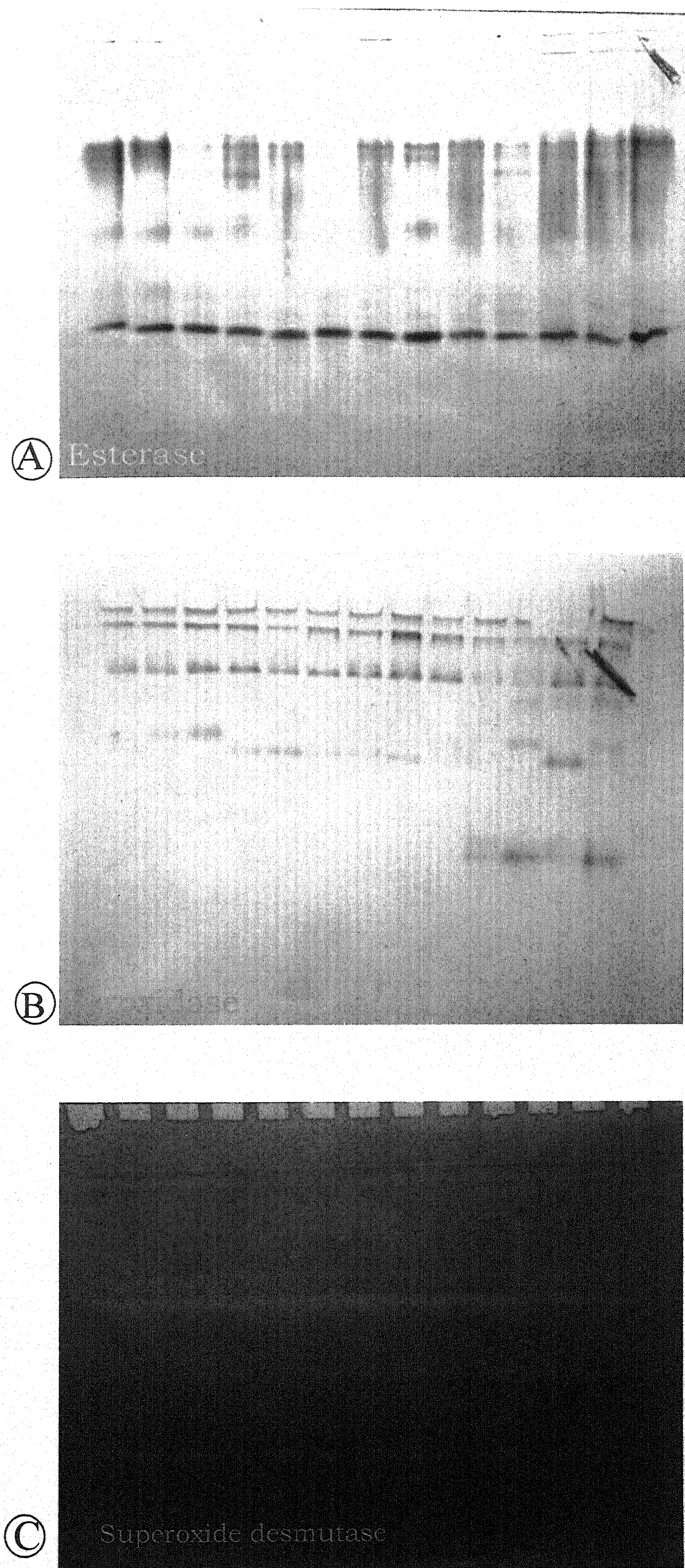


PLATE-2

Broadly two clusters were visible based on the dendrogram, the first one predominated by accessions from Rajasthan and UP, besides the African Tall. The second lower cluster consists of the accessions from UP as well as MP. This indicated that there was more diversity in the accessions selected for the analysis from UP compared to that of Rajasthan and MP. It was also evident that accessions belonging to the same cluster based on quantitative forage and seed yield traits had no corresponding placement in the isozyme-based dendrogram and vice versa.

Number of electrophoretic phenotypes (EPs) observed using three isozymes in 13 diverse accessions of maize

Isozyme	**Esterase**	**SOD**	**Peroxidase**
No. of bands	12	4	12
No. of polymorphic bands	10	1	10
No. of EPs	13	2	10

4.3 Character Association/Genetic Relationships

Fodder or seed yield is not a unitary character but depends on the development of various plant characters. Both fodder and seed yield primarily depends upon the magnitude and the nature of genetic variability present in the population. The knowledge of association of fodder and seed yield with its component traits helps in achieving success in a breeding programme. Therefore, the analysis was undertaken to determine the direct and indirect association among yield traits through path co-efficient analysis as well as to study the effects of changing environment on inter-relationships of the various yield and quality characters of fodder and seed in maize. Phenotypic coefficients of correlation for the different characters of fodder and seed yield and related characters over three environments are presented in Table 4.14 and 4.15, respectively.

(A) Correlation co-efficient analysis

(i) Fodder yield components

Estimates of the phenotypic correlation coefficients showed that dry fodder yield/plant which is a dependent trait showed highly significant positive association with green fodder yield and its contributing traits like plant height, days to 50% silking, number of leaves/plant, stem girth, leaf blade length, leaf width and sheath length. The estimates of the phenotypic correlation coefficients for green fodder yield/plant had positive and highly significant association with sheath length, dry fodder yield, days to 50% silking, number of leaves/plant, plant height, stem girth, leaf blade length, and leaf width in the order 0.939, 0.890, 0.636, 0.624, 0.613, 0.551, 0.456 and 0.391, respectively whereas it had negative and significant association with crude protein content (%).

Therefore, these characters should be kept in mind while making selection for dry fodder yield and green fodder yield. Days to 50% silking was having significant positive association with dry fodder yield and green fodder yield and its related characters like leaves number/plant, plant height, stem girth, sheath length, leaf width and leaf blade length. Plant height had significant and positive correlation with dry fodder yield and green fodder yield and its contributing characters like number of leaf/plant, leaf blade length, stem girth, sheath length and leaf width. Significant positive correlation of number of leaves per plant with stem girth, sheath length, leaf width and leaf blade length was observed besides dry fodder yield and green fodder yield.

On the other hand leaf blade length exhibited significant and positive association with dry fodder yield, green fodder yield and its related traits like sheath length, stem girth and leaf width, whereas sheath length had positive and highly significant association with stem girth besides green fodder yield and dry fodder yield.

Leaf width showed highly significant and positive association with crude protein content, stem girth, dry and green fodder yield/plant. Stem girth exhibited positive and high significant correlation with dry and green fodder yield, whereas it was negatively but significantly associated with leaf-stem

ratio. In present study leaf-stem ratio behaved as an independent trait except for stem girth with which it was negatively associated.

On the other hand crude protein content also behaved as an independent traits for all the traits except leaf width which was positive and significantly associated whereas, it was negatively associated with green fodder yield and dry fodder yield.

(ii) Seed yield components

Grain yield of a crop is the result of interaction of a number of interrelated characters. Therefore, selection should be based on these component characters after assessing their correlation with grain yield. In present investigation phenotypic correlation for 12 metric traits in maize for seed (Table 4.15) revealed that 100 seed weight, number of kernels/row, kernel width, kernel length, shank diameter and cob length exhibited positive and significant association with the seed yield/plant of the order 0.410, 0.319, 0.295, 0.276, 0.264 and 0.222, respectively whereas the remaining traits under study had no significant effect on seed yield.

Days to 50% silking showed significant and positive association with days to maturity, 100 seed weight, plant height and kernel length. Days to maturity had positive and significant association with plant height, 100 seed weight and kernel length whereas it had no significant association with yield. Plant height showed significant positive association with 100 seed weight and kernel length, while it had non-significant association with seed yield and other traits. Cob length (ear length) exhibited positive and significant correlation with seed yield and its related traits such as number of kernels/row and shank diameter. Cob width was positively and significantly associated with kernel rows/cob, kernel length and kernel width. Kernel rows/cob was positively and significantly associated with cob width. Number of kernels/row and shank diameter showed positive and significant correlation with seed yield/plant and its contributing traits like cob length.

Kernel length had significant positive association with seed yield and 100 seed weight, kernel width, cob width, days to maturity, plant height and days to 50% silking, whereas kernel width exhibited positive and significant correlation with kernel length, seed yield/plant and cob width. 100 seed

Table 4.14 **Estimates of the phenotypic correlation coefficients among various fodder yield characters.**

Characters	Days to 50% silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Green fodder yield/ plant (g)	Dry fodder yield/ plant (g)	Leaf - stem ratio	Crude Protein (%)
Days to 50% silking	1.000	0.445	0.522**	0.234*	0.297**	0.290**	0.433**	0.635**	0.671**	-0.002	-0.107
Plant height (cm)		1.000	0.597**	0.413**	0.391**	0.275**	0.405**	0.613**	0.722**	-0.102	-0.119
No. of leaves/plant			1.000	0.286**	0.310**	0.302**	0.433**	0.624**	0.628**	0.045	-0.120
Leaf blade length (cm)				1.000	0.430**	0.216*	0.366**	0.456**	0.519**	-0.141	-0.103
Sheath length (cm)					1.000	0.175	0.342**	0.939**	0.420**	-0.062	-0.129
Leaf width (cm)						1.000	0.501**	0.391**	0.444**	0.124	0.691**
Stem girth (cm)							1.000	0.551**	0.622**	-0.590**	-0.153
Green fodder yield/ plant (g)								1.000	0.890**	-0.045	-0.257**
Dry fodder yield/plant (g)									1.000	-0.750**	-0.233*
Leaf - Stem ratio										1.000	0.064
Crude Protein (%)											1.000

*, ** Significant at 5% and 1% level, respectively.

Table 4.15 Estimates of the phenotypic correlation coefficients among various seed yield characters

Characters	Days to 50% silking	Days to maturity	Plant height (cm)	Cob length (cm)	Cob width (cm)	No. of kernel row	No. of kernels/ row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	Test weight (g)	Seed yield/ plant
Days to 50% silking	1.000	0.815	0.445**	-0.102	0.050	-0.124	-0.241*	-0.086	0.238*	0.156	0.531**	-0.032
Days to maturity		1.000	0.524	-0.062	0.037	-0.089	-0.282**	-0.074	0.302**	0.142	0.503**	-0.022
Plant height (cm)			1.000	0.054	0.068	-0.124	-0.093	-0.001	0.268**	0.118	0.472**	0.118
Cob length (cm)				1.000	0.127	-0.003	0.534**	0.336**	0.006	0.090	-0.010	0.222*
Cob width (cm)					1.000	0.368**	0.055	0.157	0.359**	0.211*	0.145	0.168
No. of kernel rows						1.000	0.039	0.090	0.025	-0.370**	-0.201*	-0.052
No. of kernels/ row							1.000	0.141	-0.073	-0.096	-0.229*	0.319**
Shank diameter (cm)								1.000	0.027	0.071	0.052	0.264**
Kernel length (cm)									1.000	0.509**	0.539**	0.276**
Kernel width (cm)										1.000	0.513**	0.295**
Test weight (g)											1.000	0.410**
Seed yield/ plant												1.000

*, ** Significance at 5% and 1%, level respectively.

weight was positively associated with kernel length, days to 50% silking, kernel width, days to maturity, plant height and seed yield/plant.

(iii) Combined fodder and seed yield components

Phenotypic coefficient of correlation was also estimated to know the actual picture of relationships existing between the fodder and seed yield characters and its contributing traits. Here emphasis is given to know the pattern of association present among important characters like dry fodder yield/plant and seed yield/plant and its associated characters like number of leaves/plant, leaf length, stem thickness, kernel length, days to maturity and 100-seed weight. (Table 4.16).

Dry fodder yield/plant had positive and significant association with the seed yield/plant and its contributing traits like days to maturity, 100-seed weight, kernel length and cob length. Therefore, selection could be practiced among maize lines to develop dual-purpose varieties by selecting plants with more days to maturity, higher 100-seed weight, more kernel length and cob length alone or jointly which will increase the level of fodder and seed yield. Number of leaves/plant was having positive significant correlation among seed yield traits like test weight (100 seed), days to maturity and kernel length but it was non-significant for seed yield. Leaf length is one of the major characters for dry fodder yield but it had no significant association with seed yield while it was positively associated with days to maturity and test weight.

As stem girth increases dry fodder yield per plant would also increase besides, it was having significant and positive association with seed yield traits like days to maturity, 100 seed weight and kernel length instead of seed yield per plant.

Since, days to maturity is one of the important characters which determines dry fodder yield potential and seed yield per plant, therefore, positive correlation with days to 50% silking, number of leaves/plant, plant height, stem girth, leaf width, leaf length and sheath length appeared advantageous. Kernel length showed positive and significant correlation with dry fodder yield and its associated characters like plant height, number of leaves per plant, days to 50% silking and stem girth.

Table 4.15 Estimates of phenotypic correlation coefficients for various fodder and seed yield characters.

Characters	X-1	X-2	X-3	X-4	X-5	X-6	X-7	X-8	X-9	X-10	X-11	X-12	X-13	X-14	X-15	X-16	X-17	X-18	X-19	X-20
X-1	1.000	0.445**	0.522**	0.234*	0.297	0.290**	0.433**	0.617**	-0.002	-0.107	0.815**	-0.102	0.050	-0.124	-0.241*	-0.086	0.238*	0.156	0.531**	-0.032
X-2		1.000	0.597**	0.413**	0.391**	0.275**	0.405**	0.722**	-0.102	-0.119	0.524**	0.054	0.068	-0.124	-0.093	-0.001	0.268**	0.118	0.472**	0.118
X-3			1.000	0.286**	0.310**	0.302**	0.433**	0.628**	0.045	-0.120	0.556**	0.059	0.101	-0.093	-0.076	0.038	0.267**	0.144	0.581**	0.174
X-4				1.000	0.430**	0.216*	0.366**	0.519**	-0.141	-0.103	0.313**	0.082	0.020	-0.146	0.027	0.022	0.112	0.084	0.213**	0.133
X-5					1.000	0.175	0.342**	0.420**	-0.062	-0.129	0.284**	-0.019	0.039	-0.121	-0.039	-0.021	0.183	0.144	0.229**	0.015
X-6						1.000	0.501**	0.444**	0.124	0.069**	0.327**	-0.017	-0.024	-0.134	-0.017	-0.069	0.142	0.093	0.199*	0.045
X-7							1.000	0.622**	-0.059**	-0.153	0.423**	0.068	0.068	-0.111	-0.044	0.017	0.210*	0.132	0.316**	0.079
X-8								1.000	-0.075**	-0.233*	0.719**	0.196*	0.103	-0.054	0.006	0.070	0.316**	0.186	0.612**	0.250*
X-9									1.000	0.064	0.041	-0.082	-0.034	-0.013	0.033	-0.020	-0.097	-0.057	-0.029	0.078
X-10										1.000	-0.209	-0.114	0.002	-0.016	-0.103	-0.024	-0.019	0.021	0.015	-0.189
X-11											1.000	-0.062	0.037	-0.089	-0.282**	-0.074	0.302**	0.142	0.503**	-0.022
X-12												1.000	0.127	-0.003	0.534**	0.336**	0.006	0.098	-0.010	0.222*
X-13													1.000	0.368**	0.055	0.157	0.359**	0.211*	0.145	0.168
X-14														1.000	0.039	0.090	0.025	-0.370**	-0.201*	-0.052
X-15															1.000	0.141	-0.073	-0.096	-0.229*	0.319**
X-16																1.000	0.027	0.071	0.052	0.264**
X-17																	1.000	0.509**	0.539**	0.276**
X-18																		1.000	0.513**	0.295**
X-19																			1.000	0.410**
X-20																				1.000

*, ** Significant at 5% and 1% level respectively.

X-1 = Days to 50% silking, X-2 = Plant height, X-3 = No. of leaves/ plant, X-4 = Leaf blade length, X-5 = Sheath length, X-6 = Leaf width, X-7 = Stem girth, X-8 = Dry fodder yield/ plant, X-9 = Leaf-stem ratio, X-10 = Crude protein %, X-11 = Days to maturation, X-12 = Ear length, X-13 = Ear width, X-14 = Number of kernel rows, X-15 = Number of kernels/ row, X-16 = Shank diameter, X-17 = Kernel length, X-18 = Kernel width, X-19 = 100-seed weight and X-20 = Seed yield/ plant

Test weight or 100 seed weight is a seed yield trait but it had also positive and significant association with dry fodder yield per plant and its related traits like number of leaves per plant, days to 50% silking, plant height, stem girth, sheath length, leaf length and leaf width.

(B) Path Co-efficient analysis

Yield is an ultimate product of interaction among the characters under the influence of environment. It is quite likely that the contribution of component showing highly significant association with fodder as well as seed yield may get diluted through the interaction with other component. Further, the information on relative contribution of direct and indirect effects of components on yield help in giving appropriate weightage for the purpose of selection. Therefore, for efficient indirect selection it is important to know the causal factors for the observed association between two characters with the help of estimates of direct and indirect effects through path co-efficient analysis. Path co-efficient analysis was carried out separately for fodder and seed yield characters over the three environments.

(i) Path Co-efficient analysis for fodder yield

The path coefficient analysis carried out at phenotypic level (Table 4.17) depicts the direct and indirect effects of days to 50% silking, plant height, number of leaves/plant, leaf length, sheath length, leaf width and stem thickness on dry fodder yield. From the perusal of the table, path analysis revealed the highest positive contribution of plant height (0.3468) towards dry fodder yield/plant followed by days to 50% silking (0.3153), stem girth (0.1897), leaf length (0.1853), leaf width (0.0940), number of leaves/plant (0.0925) and sheath length (0.0011). It is to mention that sheath length has no major direct and indirect contribution to fodder yield.

Further, results indicated that plant height contributed maximum towards dry fodder yield directly and indirectly through days to 50% silking followed by stem girth, leaf length, number of leaves/plant and sheath length. Days to 50% silking exhibited substantial direct as well as indirect effects through plant height, stem girth, number of leaves/plant, leaf length and

Table 4.17 Phenotypic path coefficient analysis of various characters contributing to dry fodder yield

Characters	Days to 50% silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	r
to 50% silking	**0.3153**	0.1543	0.0483	0.0434	0.0003	0.0273	0.0821	0.671**
Plant height (cm)	0.1403	**0.3468**	0.0552	0.0765	0.0004	0.0259	0.0768	0.722**
No. of leaves/ plant	0.1646	0.2071	**0.0925**	0.0530	0.0003	0.0284	0.0821	0.628**
Leaf blade length (cm)	0.0738	0.1432	0.0265	**0.1853**	0.0005	0.0203	0.0694	0.519**
Sheath length (cm)	0.0936	0.1356	0.0287	0.0797	**0.0011**	0.0165	0.0649	0.420**
Leaf width (cm)	0.0914	0.0954	0.0279	0.0400	0.0002	**0.0940**	0.0950	0.444**
Stem girth (cm)	0.1365	0.1405	0.0401	0.0678	0.0004	0.0471	**0.1897**	0.622**

Residual = 0.2236.

r = Phenotypic correlation with dry fodder yield.

sheath length. Stem girth had positive direct effect towards dry fodder yield and also indirectly contributed positively through all the variables. Indirect effects of leaf length through plant height was high in comparison to other characters like days to 50% silking, stem girth, number of leaves/plant and sheath length. Leaf width and stem girth exhibited substantial direct and indirect effects through plant height, days to 50% silking, leaf length, number of leaves/plant and sheath length. Sheath length had very less direct effect towards dry fodder yield but it was indirectly correlated through all the variables like plant height followed by days to 50% silking, leaf length, number of leaves/plant and stem girth. The residual effect was estimated as 0.2236 for dry fodder yield/plant.

(ii) Path Co-efficient analysis for seed yield

Among seed yield contributing traits (Table 4.18). The most important yield contributing trait with high positive direct effect was shown equally by 100-seed weight and number of kernels per row (0.4553) followed by shank diameter (0.1930), kernel width (0.0651) and cob width (0.0438). Characters like number of leaves/plant, cob length and dry fodder yield/plant had negative direct effect with seed yield.

Further, results indicated that 100 seed weight had negative direct effect on yield via number of kernels per row and number of leaves/plant. Shank diameter showed substantial indirect contribution to yield through number of kernels per row. Kernel width showed positive contribution to yield directly and indirectly via 100 seed weight. Cob width had indirect significant positive effect on yield through 100 seed weight. Kernel length had significant direct effect on yield. It also showed considerable positive effects on yield indirectly through 100- seed weight. The residual effect was estimated as 0.5981 for seed yield/plant.

IV. Gene x Environment Interaction & Stability

For estimating the effect of varying environments on performance of the genotypes and to estimate the stability parameters of individual accession, two different approaches, *viz.* (I) pooled analysis of variance and (ii)

Table 4.18 Phenotypic path coefficient analysis of various characters contributing to seed yield.

Characters	No. of leaves/plant	Dry fodder yield/ plant (g)	Cob length (cm)	Cob width (cm)	No. of kernels/ row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	Test weight (g)	r
No. of leaves/plant	**-0.1011**	-0.0237	-0.0047	0.0044	-0.0346	0.0073	0.0002	0.0094	0.3167	0.174
Dry fodder yield/plant (g)	-0.0635	**-0.0377**	-0.0155	0.0045	0.0027	0.0135	0.0002	0.0121	0.3336	0.250*
Cob length (cm)	-0.0060	-0.0074	**-0.0791**	0.0056	0.2431	0.0649	0.0000	0.0064	-0.0055	0.222*
Cob width (cm)	-0.0102	-0.0039	-0.0100	**0.0438**	0.0250	0.0303	0.0003	0.0137	0.0790	0.168
No. of kernels/ row	0.0077	-0.0002	-0.0422	0.0024	**0.4553**	0.0272	-0.0001	-0.0062	-0.1248	0.319**
Shank diameter (cm)	-0.0038	-0.0026	-0.0266	0.0069	0.0642	**0.1930**	0.0000	0.0046	0.0283	0.264**
Kernel length (cm)	-0.0270	-0.0119	-0.0005	0.0157	-0.0332	0.0052	**0.0008**	0.0331	0.2938	0.276**
Kernel width (cm)	-0.0146	-0.0070	-0.0078	0.0092	-0.0437	0.0137	0.0004	**0.0651**	0.2796	0.295**
Test weight (g)	-0.0587	-0.0231	0.0008	0.0063	-0.1043	0.0100	0.0004	0.0334	**0.5451**	0.410**

Residual = 0.5981

r = Phenotypic correlation with seed yield

regression analysis of the phenotypic stability were adopted. The environmental effects were partitioned into linear and non-linear components. The stability parameters are associated with each of these components. The regression coefficient (bi) is associated with the linear components, and the mean sum of squares for G x E (Linear) represents deviation of individual regression line above or below the average regression line. The S^2di is associated with the non- linear components and mean sum of square for pooled deviation representing deviation from individual regression lines.

1. Analysis of Variance

Analysis of variance for each environment (Table 4.19 and 4.20) for fodder and seed yield and its traits showed significant difference among the accessions. The pooled analysis of variance over environments for fodder and seed yield is presented in Table 4.21 and 4.22, respectively. The difference among the accessions and the environments was significant in respect to all the characters except leaf-stem ratio. This indicated that leaf-stem ratio exhibited less variability as compared to other characters. The analysis of variance as per the model of Eberhart and Russell (1966) also showed highly significant variance due to G x E interaction, which indicated that accessions interacted differentially with environmental conditions that existed in different seasons for all the characters. Highly significant pooled deviations suggested that the accessions differed considerably with respect to their stability for all the characters. The G x E (linear) were significant for all the characters except shank diameter and environment (linear) was also significant for most of the characters except number of leaves/ plant, leaf blade length and leaf-stem ratio for fodder and for seed it was non-significant for number of kernel rows.

2. Regression analysis

Pooled analysis of variance provided the useful estimate, yet the information about adaptation of individual genotype was not available from the conventional method. Thus the method suggested by Finlay and Wilkinson (1963), which were later on modified, by Eberhart and Russell (1966) was

Table: 4.19 **Analysis of variance showing mean sum of squares of fodder characters of maize over three environments.**

Source	d.f.	Days to 50% silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Dry fodder yield/ plant (g)	Leaf - Stem ratio	Crude protein (%)
Environment - 1											
Replication	2	3.248	0.355	0.125	31.765	4.216	1.066	0.069	59.849	0.008	0.308
Genotype	100	25.321**	1955.765**	4.686**	247.828**	11.232**	2.234**	0.225**	3146.029**	0.056**	3.800**
Error	200	2.621	357.999	0.908	64.858	4.986	1.146	0.069	93.544	0.003	0.422
Environment - 2											
Replication	2	7.178	640.699	1.412	36.710	0.405	0.506	0.251	1396.529	0.007	3.543
Genotype	100	105.350**	1654.549**	5.555	262.480**	10.014**	3.781**	0.266**	1813.960**	0.037**	1.338**
Error	200	7.095	354.710	1.058	65.710	2.557	1.039	0.057	92.260	0.005	0.458
Environment - 3											
Replication	2	5.708	109.451	0.236	71.823	2.584	1.000	0.178	29.290	0.012	0.172
Genotype	100	27.265**	1595.933**	4.710	170.784**	4.840**	2.599**	0.181**	1600.800**	0.023**	2.523**
Error	200	6.940	228.474	0.738	52.262	1.964	0.771	0.770	65.409	0.006	0.301

** Significant at 1% level of probability.

Table: 4.20 **Analysis of variance showing mean sum of squares of seed characters over three environments.**

Source	d.f.	Days to maturity	Cob length (cm)	Cob width (cm)	No. of kernel row	No. of kernels/ row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	Test weight (g)	Seed yield/ plant (g)
Environment – 1											
Replication	2	36.213	56.273	0.149	0.115	487.585	0.221	0.001	0.004	1.305	849.918
Genotype	100	402.533**	19.471**	0.269**	5.573**	123.841**	0.102**	0.018**	0.018**	25.178**	5516.163**
Error	200	9.275	4.717	0.092	2.175	37.464	0.058	0.005	0.007	2.242	407.373
Environment - 2											
Replication	2	6.571	17.027	0.544	0.385	398.056	0.165	0.019	0.026	3.359	1875.956
Genotype	100	112.712**	13.775**	0.214**	4.017**	128.896**	0.107**	0.023**	0.018**	35.176**	6642.986**
Error	200	6.088	3.655	0.081	2.098	24.429	0.049	0.008	0.007	3.799	597.706
Environment – 3											
Replication	2	125.603	53.917	0.286	0.417	638.630	0.016	0.003	0.003	1.919	1006.814
Genotype	100	167.928**	20.436**	0.366**	0.533**	172.335**	0.092**	0.024**	0.018**	51.612**	6046.963**
Error	200	14.454	2.6257	0.072	0.159	27.027	0.049	0.006	0.006	2.828	336.884

** Significant at 1% level of probability.

Table 4.21 Pooled analysis of variance for different fodder characters.

Source	d. f.	Days to 50% silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Green fodder yield/plant (g)	Dry fodder yield/ plant (g)	Leaf - Stem ratio	Crude protein (%)
Environment	2	6295.875**	107297.000**	104.340**	3981.750**	174.602**	23.594**	3.580**	2299280.00**	87776.250**	1.356**	24.391**
Genotype	100	93.093**	2867.102**	9.650**	339.831**	12.929**	4.471**	0.331**	170098.320**	2829.652**	0.040	3.540**
Gene x Env.	200	32.422**	1169.559**	2.650**	170.627**	6.578**	2.072**	0.171**	58826.360**	1.865**	0.038	2.061**
Error	600	5.552	313.727	0.902	60.944	3.169	0.985	0.068	1084.222	83.730	0.004	5.830

** Significant at 1% level of probability

Table 4.22 Pooled analysis of variance for different seed characters.

Source	d. f.	Days to maturity	Cob length (cm)	Cob width (cm)	No. of kernel row	No. of kernels/ row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	Test weight (g)	Seed yield/ plant (g)
Environment	2	4.000.750**	3.656	6.730**	92.188**	1001.175**	0.245**	0.294**	0.011**	1114.516**	6655.000**
Genotype	100	467.702**	26.944**	0.290**	7.374**	231.065**	0.132**	0.029**	0.023**	46.050**	8098.587**
Gene x Env.	200	107.715**	13.369**	0.279**	3.775**	97.003**	0.084**	0.018**	0.015**	32.958**	5053.450**
Error	600	9.946	3.666	0.082	1.989	29.641	0.052	0.006	0.007	2.956	447.336

** Significant at 1% level of probability

Table 4.23 **Analysis of variance showing mean sum of square for different fodder characters for stability (Eberhart and Russell model – 1966)**

Source	d. f.	Days to 50% silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Green fodder yield/ plant (g)	Dry fodder yield/ plant (g)	Leaf - Stem ratio	Crude protein (%)
Genotype	100	31.040**	955.639**	3.216**	113.265**	4.310**	1.490**	0.110**	56699.764**	943.208**	0.013	1.180**
Env.+ (G x E)	202	31.477	740.114	1.219	69.455	2.747	0.762	0.068	27002.794	905.388	0.017	0.761
G x E (linear)	1	4197.265**	71512.198**	69.522**	2654.603**	116.440**	15.733**	2.387**	1532890.700**	58518.009**	0.904**	16.257**
Env. (linear)	100	7.858	417.130**	0.817	52.744	2.686**	0.767*	0.043	26109.214**	869.557**	0.011	1.010**
Pooled deviation	101	13.617**	305.721**	0.941**	60.406**	1.683**	0.608**	0.070**	12977.746**	370.442**	0.014**	0.360**
Pooled error	600	5.552	313.727	0.902	60.944	3.169	0.985	0.068	1084.222	83.738	0.004	0.393

*, ** Significant at 5% and 1% level of probability.

Table 4.24 **Analysis of variance showing mean sum of square for different seed characters for stability (Eberhart and Russell model – 1966)**

Source	d. f.	Days to maturity	Cob length (cm)	Cob width (cm)	No. of kernel row	No. of kernels/ row	Shank diameter (cm)	Kernel ength (cm)	Kernel width (cm)	Test weight (g)	Seed yield/ plant (g)
Genotype	100	155.919**	8.981**	0.097	2.458**	77.021**	0.044**	0.010**	0.008**	15.351**	2699.550**
Env.+ (G x E)	202	48.754	4.424	0.114	1.550	35.320	0.028	0.007	0.005	14.555	1689.785
G x E (linear)	1	2667.232**	2.420	4.486**	61.439**	667.722	0.163**	0.196**	0.008**	742.980**	4443.235**
Env. (linear)	100	18.530**	3.653	0.075	0.949	30.134	0.028	0.005	0.005	8.920	1948.424**
Pooled deviation	101	52.753**	5.208	0.111**	1.552**	34.194**	0.028**	0.007**	0.006**	12.923	1406.445**
Pooled error	600	9.939	3.667	0.082	1.989	29.640	0.052	0.006	0.007	2.956	447.321

** Significance at 1% level of probability.

used in this investigation in order to obtain the estimate of various stability parameters for each genotype under consideration.

The stability analysis technique partitions the genotype x environment interaction components of variance of each accession into two parts, therefore, each accession will be characterized by three parameters *viz.*, **i.** Mean of the genotype over all environments (Xi); **ii.** Linear regression coefficient in relation to environmental index (bi); and **iii.** Deviation from linear regression (S^2di). Since the average slope for the environmental index is one, regression coefficient for each genotype may be one (unity) or greater or lesser than one (unity). Hence, genotype with regression value of unity is considered to have an average adaptability, where as the value less than unity and above unity would give below average and above average adaptability respectively. Another stability parameter S^2di indicates the variation displayed by the accessions for a particular character over environments having similar indices. In this study, a genotype with unit regression coefficient (bi = 1) and the deviation not significantly different from zero (S^2di = 0) are considered to be stable as suggested by Singh and Chaudhary (1987).

Estimation of stability parameters of individual accession

The estimation of stability parameters (mean, bi and S^2di) of one hundred and one maize accessions with respect to morphological and quality character for fodder, seed and their contributing traits are given in table 4.25 to 4.45, and described as follows:

Days to 50% silking

Both bi and S^2di values were non-significant for days to 50% silking in 72 accessions and African Tall revealing the absence of G x E interaction. Only three accessions had both bi and S^2di significant, indicating the presence of linear and non-linear components of G x E interactions. Nine accessions had significant bi with non-significant S^2di indicating the presence of linear components of G x E interaction. On the other hand 16 accessions

had non-linear component of G x E interaction as they had significant S^2di with non-significant bi value (Table 4.25).

Twelve accessions had > 1 bi values indicating their stability to favourable environments. All these accessions were late in 50% silking as they showed their mean more than population mean. No accessions were found with less than unity regression coefficient but 88 accessions and African Tall were suitable to all kinds of environments as these were having bi values approaching unity, out of which 62 accessions were early in days to 50% silking. 94 accessions had average days to 50% silking while above average 50% silking were found in African Tall (59) followed by IC-334833 (55), IC-334853 (54) which are stable to late 50% silking and early accessions for this trait were IC-335056 (43), IC-334973 (43.22), IC-334996 (43.33) and IC-335000 (43.78).

Plant height (cm)

In case of plant height, both regression coefficients (bi) and mean square deviation (S^2di) values were non-significant for 71 accessions and African Tall revealing the absence of G x E interaction. 23 accessions had significant bi values indicating the presence of linear components of G x E interactions. On the other hand, only one accessions had non-linear components of G x E interaction as S^2di values were significant, whereas five accessions had both bi and S^2di values significant which showed the presence of linear and non-linear components of G x E interaction (Table 4.26).

Nineteen accessions had bi values more than one indicating their suitability to favourable environment, out of which 12 accessions namely IC-334830, followed by IC-335032, IC-335148, IC-334943, IC-334880, IC-334881, IC-334973, IC-334826, IC-335103, IC-334869, IC-334864 and IC-335028 were found to have mean values greater to population mean. Only five accessions were having bi values significantly negative showing their adaptability for unfavourable/poor environments in which only one accession namely IC-335158 had its mean more than population mean. 76 accessions and African Tall were found suitable to all kind of environments as these were

having bi values approaching one. Out of 100 accessions and African Tall, 46 accessions were below average, 48 accessions at average value and only one accession along with African Tall were found to have mean values greater or above average to the population mean. African Tall (268.93) had maximum plant height followed by IC-334855 (233.19), whereas IC-335060 showed minimum plant height (148.44) and stability for all kinds of environments.

Number of leaves/plant

In case of number of leaves/plant, 69 accessions and African Tall showed absence of G x E interaction as these were having non-significant regression coefficient (bi) and mean square deviation (S^2di) values. In case of both parameters only three accessions were significant showing the presence of linear and non-linear component. Twenty three accessions had significant bi revealing the presence of linear portion of G x E interaction, whereas five accessions had significant non-linear component (S^2di). (Table 4.27).

Fifteen accessions had bi values > 1, out of which three accessions namely IC-334954, IC-334836 and IC-334894 were found to have mean values greater to the population mean indicating their suitability to favourable environments while 12 accession having bi values < 1, indicated their adaptability to unfavourable environments in which six accessions namely IC-335035, followed by IC-335041, IC-334876, IC-335053, IC-335032 and IC-334889 had their mean values more than population mean. Remaining 73 accessions and African Tall were suitable for all kinds of environments as these were having bi value approaching unity, out of which 38 accessions and African Tall were found to have mean values greater to population mean and were suitable for general environments. African Tall had maximum number of leaves per plant (17.44) and suited to all type of environments. Among accessions, IC-335035 had maximum leaves/plant but not suited to all type of environments (13.63, bi = -0.77*). Minimum number of leaves/plant was recorded for IC-335086 (9.81, bi = 2.27*).

Table 4.25 **Estimation of stability parameters for days to 50% silking.**

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	45.00	0.72	25.94*	52.	IC- 335025	47.67	0.89	-1.77
2.	IC- 334825	45.67	0.71	9.62	53.	IC- 335027	52.33	-0.06	-1.79
3.	IC- 334826	45.00	0.59	17.12	54.	IC- 335028	46.56	0.94	-0.37
4.	IC- 334830	50.33	1.61*	40.01**	55.	IC- 335032	46.56	0.93	-1.82
5.	IC- 334833	55.22	0.70	61.02**	56.	IC- 335035	50.33	0.84	9.44
6.	IC- 334834	52.78	1.33	10.97	57.	IC- 335041	46.00	0.63	-1.49
7.	IC- 334836	52.89	1.16	10.72	58.	IC- 335043	45.11	1.12	18.22
8.	IC- 334837	52.22	1.66*	23.81*	59.	IC- 335045	46.67	1.11	41.78**
9.	IC- 334838	52.67	2.01*	12.00	60.	IC- 335048	47.22	1.24	-1.61
10.	IC- 334841	50.33	1.93*	50.62**	61.	IC- 335050	47.00	1.13	4.88
11.	IC- 334842	51.67	1.51	1.14	62.	IC- 335051	46.67	1.19	1.76
12.	IC- 334846	51.56	1.23	9.19	63.	IC- 335053	48.67	1.52	174.75**
13.	IC- 334848	51.33	1.04	54.83**	64.	IC- 335056	43.00	0.69	1.37
14.	IC- 334853	54.33	1.42	49.09**	65.	IC- 335060	46.22	0.00	10.67
15.	IC- 334855	51.11	1.65*	9.79	66.	IC- 335062	44.33	0.84	6.50
16.	IC- 334863	53.78	1.19	51.79**	67.	IC- 335068	44.00	0.82	-0.03
17	IC- 334864	49.11	1.42	1.47	68.	IC- 335069	46.11	0.91	-1.59
18.	IC- 334867	52.11	1.84*	15.44	69.	IC- 335079	46.00	1.03	10.79
19.	IC- 334869	50.78	1.39	16.65	70.	IC- 335082	48.22	1.24	-0.92
20.	IC- 334871	51.78	1.15	6.18	71.	IC- 335086	44.11	0.42	7.02
21.	IC- 334872	51.22	1.80*	8.43	72.	IC- 335089	45.78	0.66	2.08
22.	IC- 334876	49.89	1.05	2.58	73.	IC- 335092	45.00	0.79	23.38*
23.	IC- 334877	51.89	1.22	20.59*	74.	IC- 335094	44.89	0.75	4.08
24.	IC- 334879	51.44	1.98*	1.49	75.	IC- 335098	45.78	1.11	2.66
25.	IC- 334880	50.67	1.82*	7.00	76.	IC- 335103	47.89	0.48	-1.74
26.	IC- 334881	50.56	1.73*	17.26	77.	IC- 335109	45.22	0.94	1.00
27.	IC- 334884	51.22	1.04	14.07	78.	IC- 335110	45.11	0.60	-0.19
28.	IC- 334889	45.22	0.88	9.38	79.	IC- 335111	44.33	0.38	-1.85
29.	IC- 334904	51.44	0.47	-1.71	80.	IC- 335112	46.11	1.19	24.92*
30.	IC- 334915	44.22	-0.09	-1.64	81.	IC- 335115	45.22	0.95	14.51
31.	IC- 334920	44.67	0.61	26.40*	82.	IC- 335116	45.56	0.83	33.63*
32.	IC- 334929	47.67	0.71	2.04	83.	IC- 335117	45.78	0.80	12.90
33.	IC- 334932	50.56	1.30	5.06	84.	IC- 335120	47.22	0.94	2.81
34.	IC- 334942	52.67	1.63*	5.44	85.	IC- 335122	45.00	0.97	20.68*
35.	IC- 334943	52.44	1.53	2.03	86.	IC- 335128	47.78	0.94	30.62*
36.	IC- 334944	50.33	1.07	-1.64	87.	IC- 335131	46.11	0.92	1.87
37.	IC- 334945	52.89	1.81*	3.27	88.	IC- 335138	47.33	0.77	1.12
38.	IC- 334947	44.89	0.82	7.94	89.	IC- 335141	45.56	1.02	25.29*
39.	IC- 334949	50.56	1.38	-1.68	90.	IC- 335144	48.00	1.07	-1.64
40.	IC- 334954	50.78	1.16	-0.95	91.	IC- 335148	46.56	0.83	33.63*
41.	IC- 334955	45.22	0.82	7.94	92.	IC- 335149	47.44	1.35	-0.35
42.	IC- 334957	48.44	0.97	-1.81	93.	IC- 335152	45.00	0.83	0.32
43.	IC- 334973	43.22	0.30	1.47	94.	IC- 335156	47.33	0.69	-1.13
44.	IC- 334974	47.22	0.83	18.78	95.	IC- 335158	46.11	1.11	0.88
45.	IC- 334989	44.89	1.06	-1.34	96.	IC- 335164	46.11	0.47	-0.12
46.	IC- 334996	45.56	0.68	1.18	97.	IC- 335169	45.44	0.92	3.91
47.	IC- 334999	43.33	0.42	14.94	98.	IC- 335173	46.00	0.96	6.34
48.	IC- 335000	43.78	0.67	9.68	99.	IC- 335178	46.33	0.96	0.25
49.	IC- 335009	45.67	0.52	5.55	100.	IC- 335184	44.67	0.71	4.12
50.	IC- 335017	46.78	1.05	9.14	101.	African Tall	59.22	0.04	0.17
51.	IC- 335024	47.33	1.08	0.17					

Table 4.26 **Estimation of stability parameters for plant height.**

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	168.90	0.65	-95.72	52.	IC- 335025	178.45	1.36	-76.67
2.	IC- 334825	183.85	1.15	571.07	53.	IC- 335027	170.15	0.51	111.34
3.	IC- 334826	194.52	2.41*	-102.72	54.	IC- 335028	191.15	2.08*	153.82
4.	IC- 334830	221.35	1.68*	44.44	55.	IC- 335032	210.70	1.82*	454.66
5.	IC- 334833	214.86	0.81	209.13	56.	IC- 335035	212.11	-0.03	255.27
6.	IC- 334834	215.08	0.35	-37.02	57.	IC- 335041	203.15	-0.02	142.12
7.	IC- 334836	203.54	0.16	-95.45	58.	IC- 335043	185.37	0.02	493.67
8.	IC- 334837	207.80	1.31	436.03	59.	IC- 335045	180.87	1.13	45.25
9.	IC- 334838	211.79	0.22	-100.28	60.	IC- 335048	201.84	0.56	24.21
10.	IC- 334841	206.46	0.25	-56.33	61.	IC- 335050	199.30	1.52	-38.35
11.	IC- 334842	199.98	-0.20	28.22	62.	IC- 335051	189.82	0.72	289.36
12.	IC- 334846	221.02	0.93	-104.51	63.	IC- 335053	177.37	0.59	1887.29*
13.	IC- 334848	203.00	0.88	1243.66*	64.	IC- 335056	153.71	0.19	-72.60
14.	IC- 334853	206.59	1.43	28.23	65.	IC- 335060	148.44	0.40	-16.86
15.	IC- 334855	233.19	0.58	-45.09	66.	IC- 335062	156.78	-0.37*	247.22
16.	IC- 334863	184.94	2.26*	51.46	67.	IC- 335068	157.31	0.44	665.01
17	IC- 334864	191.52	2.75*	-97.60	68.	IC- 335069	154.89	0.23	-55.86
18.	IC- 334867	186.13	2.87*	-7.39	69.	IC- 335079	161.33	0.99	-102.62
19.	IC- 334869	192.59	2.27*	-103.95	70.	IC- 335082	166.07	1.81*	1510.49*
20.	IC- 334871	181.59	2.44*	214.69	71.	IC- 335086	154.63	1.15	-76.13
21.	IC- 334872	196.08	1.08	-103.65	72.	IC- 335089	189.16	1.25	70.26
22.	IC- 334876	181.43	2.14*	504.70	73.	IC- 335092	181.94	-0.38*	-83.16
23.	IC- 334877	191.67	0.74	876.08	74.	IC- 335094	188.62	2.37*	-104.42
24.	IC- 334879	185.22	1.33	464.57	75.	IC- 335098	173.32	-0.42*	-47.68
25.	IC- 334880	203.47	1.89*	841.20	76.	IC- 335103	193.04	2.50*	-87.89
26.	IC- 334881	200.53	2.75*	61.80	77.	IC- 335109	181.35	1.32	-25.40
27.	IC- 334884	202.98	0.44	-62.21	78.	IC- 335110	192.69	0.83	-34.29
28.	IC- 334889	169.70	0.83	-104.16	79.	IC- 335111	182.88	-0.21	21.02
29.	IC- 334904	173.07	-1.14*	300.31	80.	IC- 335112	188.04	-0.14	-104.57
30.	IC- 334915	210.46	0.66	-28.24	81.	IC- 335115	186.63	0.29	-46.09
31.	IC- 334920	189.15	0.30	-103.76	82.	IC- 335116	168.67	1.02	-57.87
32.	IC- 334929	195.33	0.50	-52.62	83.	IC- 335117	175.26	0.64	-94.72
33.	IC- 334932	185.74	0.98	-59.65	84.	IC- 335120	175.84	-0.15	234.76
34.	IC- 334942	211.84	1.23	305.41	85.	IC- 335122	187.26	1.47	-80.84
35.	IC- 334943	206.00	2.25*	25.15	86.	IC- 335128	193.80	1.61	413.94
36.	IC- 334944	169.78	1.09	601.76	87.	IC- 335131	196.46	0.81	-51.99
37.	IC- 334945	196.07	1.29	40.16	88.	IC- 335138	192.48	0.76	713.06
38.	IC- 334947	169.51	1.50	723.40	89.	IC- 335141	176.85	0.34	-103.09
39.	IC- 334949	192.20	1.61	239.01	90.	IC- 335144	175.30	1.12	1378.00
40.	IC- 334954	197.13	1.19	51.70	91.	IC- 335148	209.61	1.96*	512.36
41.	IC- 334955	191.37	0.98	360.29	92.	IC- 335149	183.23	0.43	-97.39
42.	IC- 334957	177.69	0.92	-103.52	93.	IC- 335152	195.35	0.24	65.52
43.	IC- 334973	198.96	1.98*	59.67	94.	IC- 335156	182.11	1.03	1104.33*
44.	IC- 334974	184.52	1.22	-62.54	95.	IC- 335158	197.59	-0.85*	941.84
45.	IC- 334989	175.37	1.95*	124.79	96.	IC- 335164	192.70	1.55	-75.88
46.	IC- 334996	186.22	1.61	32.21	97.	IC- 335169	184.07	0.49	1949.27*
47.	IC- 334999	195.80	1.07	1016.36	98.	IC- 335173	191.58	1.00	414.79
48.	IC- 335000	205.78	1.14	-78.37	99.	IC- 335178	197.74	1.24	-90.62
49.	IC- 335009	203.63	1.55	5.24	100.	IC- 335184	186.24	0.54	-7.41
50.	IC- 335017	194.48	1.26	-90.52	101.	African Tall	268.93	0.14	-104.40
51.	IC- 335024	195.11	1.53	188.23					

Table 4.27 **Estimation of stability parameters for number of leaves/plant.**

S. No.	Acc. No.	Mean	bi	S ^{2}di	S. No	Acc. No.	Mean	bi	S ^{2}di
1.	IC- 334821	9.92	0.83	1.20	52.	IC- 335025	11.93	1.22	0.27
2.	IC- 334825	11.56	0.53	0.17	53.	IC- 335027	12.33	1.46	-0.22
3.	IC- 334826	11.37	1.80	0.47	54.	IC- 335028	12.22	1.43	0.54
4.	IC- 334830	13.04	1.16	1.18	55.	IC- 335032	12.89	-0.57*	1.43
5.	IC- 334833	13.00	1.28	0.16	56.	IC- 335035	13.63	-0.77*	-0.28
6.	IC- 334834	12.55	1.87	0.93	57.	IC- 335041	13.33	-0.50*	-0.25
7.	IC- 334836	12.55	2.94*	-0.23	58.	IC- 335043	11.15	1.60	-0.27
8.	IC- 334837	12.67	-0.13	0.01	59.	IC- 335045	11.15	1.29	-0.05
9.	IC- 334838	11.78	0.19	-0.01	60.	IC- 335048	11.81	1.26	-0.30
10.	IC- 334841	13.07	1.38	-0.27	61.	IC- 335050	11.74	1.73	0.11
11.	IC- 334842	13.33	1.14	-0.29	62.	IC- 335051	12.33	1.22	2.32
12.	IC- 334846	12.52	1.04	-0.30	63.	IC- 335053	12.93	-1.28*	1.57
13.	IC- 334848	12.33	0.09	2.69	64.	IC- 335056	10.81	1.06	0.15
14.	IC- 334853	12.44	2.16	-0.08	65.	IC- 335060	10.18	0.34	0.47
15.	IC- 334855	13.15	1.34	1.78	66.	IC- 335062	10.00	0.23	2.72
16.	IC- 334863	12.74	1.12	1.81	67.	IC- 335068	9.89	1.05	1.18
17	IC- 334864	13.37	1.67	2.23	68.	IC- 335069	10.11	-0.31*	-0.19
18.	IC- 334867	11.70	2.53*	0.34	69.	IC- 335079	11.04	0.81	0.53
19.	IC- 334869	12.52	1.00	5.1*	70.	IC- 335082	10.63	2.77*	2.61
20.	IC- 334871	12.63	1.19	-0.26	71.	IC- 335086	9.81	2.27*	-0.08
21.	IC- 334872	12.07	0.01	0.45	72.	IC- 335089	11.70	0.91	-0.12
22.	IC- 334876	13.22	-0.35*	-0.09	73.	IC- 335092	11.22	-1.47*	-0.28
23.	IC- 334877	11.70	1.09	-0.30	74.	IC- 335094	11.19	0.60	0.55
24.	IC- 334879	12.41	0.49	0.95	75.	IC- 335098	11.41	-1.45*	0.03
25.	IC- 334880	12.78	0.76	1.16	76.	IC- 335103	11.67	3.67*	3.49*
26.	IC- 334881	12.44	1.38	3.16	77.	IC- 335109	11.44	2.61*	-0.24
27.	IC- 334884	12.26	2.50*	1.75	78.	IC- 335110	12.44	0.43	1.13
28.	IC- 334889	12.37	-1.20*	-0.30	79.	IC- 335111	12.16	0.73	-0.28
29.	IC- 334904	12.00	0.48	-0.24	80.	IC- 335112	11.52	1.40*	0.17*
30.	IC- 334915	12.48	1.54	0.29	81.	IC- 335115	11.26	-1.68*	-0.21
31.	IC- 334920	11.82	0.23	0.46	82.	IC- 335116	12.26	1.19	1.20
32.	IC- 334929	12.63	0.77	3.37*	83.	IC- 335117	11.52	2.64*	0.35
33.	IC- 334932	13.07	1.95	1.69	84.	IC- 335120	11.16	0.45	-0.06
34.	IC- 334942	13.15	0.41	-0.06	85.	IC- 335122	11.90	0.00	0.10
35.	IC- 334943	13.48	1.87	0.30	86.	IC- 335128	12.30	0.72	-0.30
36.	IC- 334944	11.41	1.63	1.24	87.	IC- 335131	12.33	0.82	-0.30
37.	IC- 334945	12.89	1.46	-0.10	88.	IC- 335138	11.63	0.57	-0.10
38.	IC- 334947	11.89	1.29	-0.17	89.	IC- 335141	10.63	0.05	-0.29
39.	IC- 334949	12.85	2.06	0.10	90.	IC- 335144	10.89	0.07	1.27
40.	IC- 334954	12.67	2.95*	-0.29	91.	IC- 335148	11.89	2.82	0.06
41.	IC- 334955	11.89	0.54	0.42	92.	IC- 335149	10.56	1.66	-0.13
42.	IC- 334957	11.78	0.67	-0.22	93.	IC- 335152	11.22	2.82*	0.06
43.	IC- 334973	11.45	0.84	-0.26	94.	IC- 335156	11.15	0.73	0.13
44.	IC- 334974	12.22	1.93	0.19	95.	IC- 335158	11.74	-0.95*	7.03**
45.	IC- 334989	11.48	0.97	0.15	96.	IC- 335164	11.15	1.54	0.55
46.	IC- 334996	10.55	2.94*	-0.23	97.	IC- 335169	10.85	0.99	4.39*
47.	IC- 334999	11.44	2.40*	2.94	98.	IC- 335173	10.90	1.23	0.14
48.	IC- 335000	11.74	1.17	-0.03	99.	IC- 335178	12.15	0.97	0.15
49.	IC- 335009	12.00	0.90	1.83	100.	IC- 335184	10.70	0.60	-0.29
50.	IC- 335017	12.15	0.41	-0.06	101.	African Tall	17.44	0.58	0.02
51.	IC- 335024	11.92	3.05*	-0.23					

Leaf blade length (cm)

From the perusal of Table 4.28, both bi and S^2di values of 64 accessions revealed the absence of G x E interaction, as both bi and S^2di were non-significant in these accessions. Regression coefficient (bi) alone was significant in 31 accessions and African Tall exhibited linear component of G x E interaction. Only three accessions had both linear and non-linear components of G x E interactions, as bi and S^2di of these accessions were significant, whereas non-linear components of G x E interaction were reported in two accessions.

Fourteen accessions had above average response, 21 accessions and African Tall below average response and remaining 65 accessions were average in response, which showed their adaptability to favourable, unfavourable and general environments, respectively. Thirteen accessions and African Tall had above average mean performance than population mean, whereas eight accessions had mean values below average. However, 79 accessions were average in performance for this character. African Tall had maximum leaf blade length (104.81) specially suited to favourable environments due to its below average response (bi = -23*). Among the accessions, IC-334999 had maximum leaf blade length (99.00), which was suited to unfavourable environments due to its above average response and was stable. Among germplasm lines, six accessions namely IC-334841, IC-334884, IC-334889, IC-334904, IC-334957 and IC-334989 were not stable for leaf blade length.

Sheath length (cm)

In case of sheath length, both bi and S^2di were non-significant for 64 accessions and African Tall showed absence of G x E interaction. 35 accessions were having only significant bi indicating the presence of linear components of G x E interaction and non-linear components of G x E was observed in only one accession while no accessions was having significant bi and S^2di values (Table 4.29).

Table 4.28 Estimation of stability parameters for leaf blade length.

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	83.96	2.21	-14.52	52.	IC- 335025	89.04	0.44	64.54
2.	IC- 334825	84.36	-1.29*	28.33	53.	IC- 335027	86.24	1.89	-17.85
3.	IC- 334826	85.55	1.84	77.77	54.	IC- 335028	91.07	0.52	113.93
4.	IC- 334830	90.81	-0.87*	71.75	55.	IC- 335032	91.15	0.46	150.07
5.	IC- 334833	98.37	0.13	-2.74	56.	IC- 335035	86.00	1.38	-19.52
6.	IC- 334834	94.83	-0.79*	56.78	57.	IC- 335041	86.57	0.94	37.20
7.	IC- 334836	90.70	-1.75*	43.56	58.	IC- 335043	95.04	0.63	-17.12
8.	IC- 334837	98.44	-2.00*	-20.33	59.	IC- 335045	89.07	0.36	-0.01
9.	IC- 334838	91.09	-0.09	2.40	60.	IC- 335048	89.83	2.84*	-16.67
10.	IC- 334841	88.35	-1.66*	237.18*	61.	IC- 335050	91.33	1.23	-4.43
11.	IC- 334842	88.43	2.32	5.83	62.	IC- 335051	84.56	2.27	-18.31
12.	IC- 334846	97.00	1.99	29.29	63.	IC- 335053	95.89	-0.60*	18.35
13.	IC- 334848	88.65	2.19	13.67	64.	IC- 335056	79.10	3.00*	20.58
14.	IC- 334853	90.62	0.02	47.68	65.	IC- 335060	72.93	2.02	98.12
15.	IC- 334855	98.83	-0.13	54.40	66.	IC- 335062	79.82	-0.34	25.75
16.	IC- 334863	89.04	1.41	36.63	67.	IC- 335068	65.67	2.30	-18.89
17	IC- 334864	84.48	2.67*	8.30	68.	IC- 335069	78.71	0.09	38.71
18.	IC- 334867	87.87	2.32	-14.41	69.	IC- 335079	81.27	2.68*	-15.18
19.	IC- 334869	86.09	2.00	-11.75	70.	IC- 335082	82.34	3.09*	-19.13
20.	IC- 334871	90.57	1.19	-0.16	71.	IC- 335086	80.28	0.56	95.96
21.	IC- 334872	97.93	1.62	-6.00	72.	IC- 335089	86.94	2.19	69.33
22.	IC- 334876	83.04	-0.33	118.88	73.	IC- 335092	88.35	1.81	-19.90
23.	IC- 334877	90.84	-0.07	41.88	74.	IC- 335094	85.91	2.77*	114.82
24.	IC- 334879	92.57	-0.83*	-13.21	75.	IC- 335098	79.90	1.94	208.43
25.	IC- 334880	84.95	-0.61*	-0.03	76.	IC- 335103	87.83	1.01	147.77
26.	IC- 334881	86.07	1.28	-19.57	77.	IC- 335109	88.54	0.76	15.12
27.	IC- 334884	86.67	-1.90*	252.98*	78.	IC- 335110	88.04	0.29	-7.47
28.	IC- 334889	76.91	0.42	272.64*	79.	IC- 335111	82.67	0.84	12.99
29.	IC- 334904	75.62	-0.69*	365.38*	80.	IC- 335112	80.83	2.64*	-5.73
30.	IC- 334915	89.11	1.32	-1.38	81.	IC- 335115	78.23	0.05	-14.84
31.	IC- 334920	79.29	0.46	106.43	82.	IC- 335116	74.61	2.03	-5.40
32.	IC- 334929	82.65	0.03	64.03	83.	IC- 335117	82.83	-0.28	71.17
33.	IC- 334932	80.61	0.73	-19.90	84.	IC- 335120	87.66	1.87	7.62
34.	IC- 334942	81.57	-1.29*	-20.32	85.	IC- 335122	86.42	0.69	12.06
35.	IC- 334943	86.75	-0.40	21.14	86.	IC- 335128	87.39	-0.44	69.65
36.	IC- 334944	79.18	1.35	-18.79	87.	IC- 335131	84.90	1.80	51.15
37.	IC- 334945	88.11	-0.30	66.02	88.	IC- 335138	85.38	1.44	-17.82
38.	IC- 334947	88.74	-0.05	26.57	89.	IC- 335141	80.86	0.83	-10.43
39.	IC- 334949	93.78	4.24*	-18.34	90.	IC- 335144	83.07	-0.76*	140.12
40.	IC- 334954	90.56	-0.62*	44.41	91.	IC- 335148	90.24	1.21	105.36
41.	IC- 334955	86.60	2.43	-4.70	92.	IC- 335149	88.11	0.18	-12.96
42.	IC- 334957	84.78	-0.41	453.18**	93.	IC- 335152	80.33	4.54*	4.75
43.	IC- 334973	87.49	0.25	-1.04	94.	IC- 335156	88.04	0.01	-13.15
44.	IC- 334974	85.02	3.17*	-20.28	95.	IC- 335158	91.42	2.92	-16.61
45.	IC- 334989	75.87	1.71	318.1*	96.	IC- 335164	88.54	-0.08	7.67
46.	IC- 334996	84.28	2.02	20.21	97.	IC- 335169	80.69	3.01*	-20.26
47.	IC- 334999	99.00	4.55*	-2.46	98.	IC- 335173	82.85	2.33	-13.66
48.	IC- 335000	88.04	0.16	18.48	99.	IC- 335178	92.53	1.52	-8.31
49.	IC- 335009	95.35	1.64	-17.26	100.	IC- 335184	88.39	1.71	-1.00
50.	IC- 335017	87.89	3.02*	-17.10	101.	African Tall	104.81	-0.23	-1.68
51.	IC- 335024	86.50	2.02	4.74					

Table 4.29 Estimation of stability parameters for sheath length.

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	15.65	1.34	-0.27	52.	IC- 335025	16.19	0.18	-0.45
2.	IC- 334825	15.26	0.47	-0.91	53.	IC- 335027	16.69	1.16	-0.79
3.	IC- 334826	17.28	5.09*	0.91	54.	IC- 335028	16.60	2.00	0.60
4.	IC- 334830	18.65	1.51	2.40	55.	IC- 335032	17.31	2.83*	1.90
5.	IC- 334833	19.49	2.17	-1.03	56.	IC- 335035	18.44	2.54*	-0.87
6.	IC- 334834	17.67	1.14	-0.99	57.	IC- 335041	16.87	-0.61*	-1.02
7.	IC- 334836	16.96	-1.86*	0.60	58.	IC- 335043	17.54	-2.68*	0.64
8.	IC- 334837	17.07	0.94	1.36	59.	IC- 335045	16.69	0.20	4.82
9.	IC- 334838	16.89	1.26	-0.40	60.	IC- 335048	17.33	0.99	-1.04
10.	IC- 334841	18.09	-0.67*	-1.00	61.	IC- 335050	17.28	1.19	-0.34
11.	IC- 334842	17.91	1.57	-0.97	62.	IC- 335051	16.46	0.82	-0.75
12.	IC- 334846	19.33	1.92	0.64	63.	IC- 335053	17.93	-0.27*	1.18
13.	IC- 334848	16.72	0.75	-0.99	64.	IC- 335056	15.91	1.27	0.17
14.	IC- 334853	17.93	0.06	-0.69	65.	IC- 335060	13.09	0.83	0.77
15.	IC- 334855	18.93	1.80	-0.41	66.	IC- 335062	14.82	-1.12*	-0.98
16.	IC- 334863	16.96	1.57	-1.04	67.	IC- 335068	14.01	0.62	-0.26
17	IC- 334864	16.87	5.70*	5.96	68.	IC- 335069	15.39	-0.27*	-0.18
18.	IC- 334867	17.53	3.80*	-0.72	69.	IC- 335079	15.69	0.73	-0.59
19.	IC- 334869	16.86	2.65*	-0.43	70.	IC- 335082	14.67	0.32	11.54
20.	IC- 334871	17.80	0.63	0.80	71.	IC- 335086	15.98	0.78	-1.02
21.	IC- 334872	18.61	1.42	0.88	72.	IC- 335089	18.28	1.94	2.19
22.	IC- 334876	16.71	-0.04	-0.35	73.	IC- 335092	16.06	-0.10	4.72
23.	IC- 334877	17.34	-0.18	0.23	74.	IC- 335094	16.12	2.59*	-0.99
24.	IC- 334879	19.06	1.87	3.81	75.	IC- 335098	16.12	1.68	2.34
25.	IC- 334880	17.64	2.73*	5.70	76.	IC- 335103	17.18	2.50	4.74
26.	IC- 334881	17.21	1.67	-0.84	77.	IC- 335109	17.26	1.62	-0.92
27.	IC- 334884	15.96	-1.44*	5.00	78.	IC- 335110	16.62	0.41	0.14
28.	IC- 334889	14.11	-2.03*	-1.02	79.	IC- 335111	16.23	-1.66*	2.09
29.	IC- 334904	15.37	-2.15*	0.14	80.	IC- 335112	16.19	0.42	-0.95
30.	IC- 334915	18.04	-0.61*	-0.50	81.	IC- 335115	15.73	0.10	-0.12
31.	IC- 334920	16.46	0.96	2.72	82.	IC- 335116	15.41	0.45	2.71
32.	IC- 334929	15.81	0.40	-0.94	83.	IC- 335117	15.23	0.37	-0.40
33.	IC- 334932	16.20	2.61*	-0.14	84.	IC- 335120	17.91	-0.09	-1.05
34.	IC- 334942	17.52	2.46*	0.43	85.	IC- 335122	17.02	1.12	-1.06
35.	IC- 334943	16.79	2.51	-0.23	86.	IC- 335128	15.94	-1.08*	-1.05
36.	IC- 334944	15.87	2.24	-0.87	87.	IC- 335131	16.20	0.13	-0.53
37.	IC- 334945	18.06	-0.63*	-0.82	88.	IC- 335138	15.95	1.38	-0.79
38.	IC- 334947	15.67	1.67	-0.99	89.	IC- 335141	16.07	1.48	-1.05
39.	IC- 334949	17.54	3.56*	-1.05	90.	IC- 335144	16.17	0.16	0.11
40.	IC- 334954	17.73	1.24	-0.09	91.	IC- 335148	18.10	4.10*	-1.04
41.	IC- 334955	15.79	2.13*	0.27	92.	IC- 335149	16.83	-0.39*	-0.20
42.	IC- 334957	17.35	-2.47*	1.30	93.	IC- 335152	15.58	0.15	-0.37
43.	IC- 334973	16.96	0.44	1.15	94.	IC- 335156	15.99	-0.37*	-0.93
44.	IC- 334974	16.04	1.67	-0.96	95.	IC- 335158	16.31	1.15	0.27
45.	IC- 334989	14.99	5.12*	2.31	96.	IC- 335164	17.23	1.27	-1.04
46.	IC- 334996	15.72	3.72*	1.49	97.	IC- 335169	15.52	1.05	15.53*
47.	IC- 334999	17.43	2.36	5.04	98.	IC- 335173	16.27	1.26	3.74
48.	IC- 335000	16.39	0.70	-1.05	99.	IC- 335178	17.15	0.19	0.01
49.	IC- 335009	17.04	1.08	0.02	100.	IC- 335184	17.96	0.99	-1.04
50.	IC- 335017	16.73	0.28	0.70	101.	African Tall	20.53	0.03	0.07
51.	IC- 335024	16.44	1.49	0.59					

Twelve accessions had bi values < 1 showed their suitability to unfavourable/poor environments. 18 accessions were having above average response (bi = 71) while 70 accessions and African Tall had average response (bi = 1) showing their adaptability to favourable and general environments, respectively. 78 accessions had average sheath length, 12 accessions below average mean and 10 accessions and African Tall were having mean above average. Among the stable maize accessions, 20 accessions were stable for favourable environment with high mean values than population mean whereas only one accession namely IC-335169 was unstable. African Tall had maximum sheath length (20.53) followed by IC-334833, IC-334846 and IC-334871. All of these were stable for all kinds of environments.

Leaf width (cm)

Simultaneous consideration of two stability parameters bi and S^2di suggested the absence of G x E interaction in 50 accessions, as the estimates of these parameters were non-significant in their cases. Linear components were present for 51 accessions and African Tall as shown by significant bi values (Table 4.30). No accessions were having significant bi and S^2di values and only significant S^2di values.

Forty nine accessions had average response (bi = 1) indicating their adaptability to all kinds of environments. Twenty one accessions were having above average response (bi > 1) which showed their suitability to favourable environments, whereas, another 30 accession and African Tall were suitable for poor environments as these accessions had below average response (bi = < 1). Twenty one accessions had below average mean performance for leaf width, 62 accessions had average leaf width and 13 accessions and African Tall had above average leaf width. Maximum leaf width was recorded in IC-334932 (10.32) followed by African Tall (10.21). IC-334932 (bi = 1.90) and African Tall (bi = -0.82*) showed above average and below average response, respectively. Among stable accession, 53 accessions were having their mean more than population mean in which eight accessions had above average response and 19 accessions had below average response.

Stem girth (cm)

Stability parameters for stem girth (table 4.31) indicated that 74 accessions and African Tall had non- significant bi and S^2di showing absence of G x E interaction. Only two accessions had significant bi and S^2di indicating the presence of linear as well as non- linear component. Eighteen accessions had significant bi revealing the presence of linear portion of G x E interaction, whereas six accessions had significant non- linear component (S^2di).

Twelve accessions had bi values > 1, another eight accessions were having < 1 bi values and remaining 80 accessions and African Tall had bi values equal to one or unity, indicating their adaptability to favourable, unfavourable and general environments, respectively. Forty six accessions had below average mean, 54 accessions had average mean and only African Tall was having above average mean value than the population means. Thickest stem was observed in African Tall (2.94), which was stable to all type of environments (bi = 0.87). Among stable maize accessions maximum stem girth was recorded for IC-335048 (2.37) followed by IC-334848 and was stable to favourable environments. Eight accessions namely IC-334836, IC-334863, IC-335035, IC- 335045, IC- 335050, IC-335089, IC-335178 and IC-335184 were found to be stable.

Green fodder yield/plant (g)

In case of green fodder yield/plant, 25 accessions had non-significant bi and S^2di values indicating the absence of G x E interactions. Twenty accessions and African Tall had significant bi indicating the presence of linear components of G x E interaction and hence prediction of their performance across environments would be easy. (Table 4.32)

Seventeen accessions had both linear and non-linear significant for these accessions, whereas 38 accessions had significant S^2di indicating the presence of non-linear components of G x E interaction and hence prediction of their performance across environments would become difficult. Seventeen accessions and African Tall had bi > 1 values indicating their adaptability to unfavourable/poor environments, out of which African Tall and eight

accessions namely IC- (334855, followed by 334841, 335035, 334837, 335110, 334836, 335111 and 335092) were having their mean more than the population mean whereas eighteen accessions had bi > 1 in which ten accessions namely IC - (334833, 334943, 335103, 334949, 334864, 334863, 335028, 334826, 334867 and 335089) showed their suitability to favourable environments. Remaining 65 accessions were suitable for general/all kind of environments as these were having regression coefficient equal to unity (bi = 1). Consideration of mean performance for individual accession indicated that African Tall had above average, 70 accessions showed below average and remaining 30 accessions had average mean performance for green fodder yield/plant. Out of 45 stable accessions only eighteen accessions and African Tall exhibited high mean performance.

Dry fodder yield/plant (g)

Thirty three accessions and African Tall had non-significant bi and S^2di values indicating the absence of G x E interactions. The S^2di was significant for 19 accessions revealing the presence of non-linear component of G x E interactions and hence prediction of their performance across the environments would be difficult. Nineteen accessions had both bi and S^2di values significant whereas 29 accessions had significant bi indicating the presence of linear component (Table 4.33).

Sixty two accessions and African Tall were found stable as these were having non-significant S^2di. Thirty one accessions had bi values more than unity out of which 19 accessions had their mean more than population mean. Sixteen accessions had bi values less than unity in which only five accessions had their mean performance more than population mean and 53 accessions and African Tall were having bi equal to unity in which 31 accessions and African Tall were having their mean more than population mean indicating their stability to favourable, unfavourable/poor and general environment, respectively. Out of 101accessions including African Tall, 29 accessions were below average, 69 accessions average and remaining two accessions and African Tall was above average in performance for dry fodder yield. Maximum dry fodder yield was recorded in African Tall (170.29) followed by IC-334833

(130.57) and IC-334846 (128.21). Among the maximum dry fodder yielding accessions, IC-334833 yielded maximum dry fodder in favourable environments while IC-334846 yielded maximum stable yield across all given environments. Twenty two accessions exhibited higher mean than population mean but were found unstable. These were IC-334825, IC-334830, IC-334837, IC-334838, IC-334831, IC-334879, IC-334929, IC-334932, IC-334955, IC-334996, IC-334999, IC-335000, IC-335032, IC-335041, IC-335053, IC-335092, IC-335128, IC-335148, IC-335149, IC-335158, and IC-335184.

Leaf- stem ratio

From the perusal of Table 4.34, fifty four accessions were having non-significant bi and S^2di values showing absence of G x E interactions. Forty two accessions and African Tall had only significant bi indicating that G x E interaction was linear in nature and performance of these accessions could be predictable. Significance for both bi as well as S^2di was observed for only two accessions showing that both linear and non-linear types of interactions accounted for the G x E interaction. There was only one accession with significant S^2di and as such the performance of this accession was not predictable across the environments.

In general, most of the accessions (58 accessions and African Tall) had bi approaching to unity (bi = 1) showing their adaptability for general environment. Out of these, 45 accessions and African Tall were having mean values greater or equal to the population mean. Eighteen accessions had bi > 1 showing their suitability to favourable environments, out of which only five accessions had mean values more or equal to population mean. Twenty four accessions were having bi < 1 indicating their adaptability to unfavourable environments, in which four accessions had mean values more than or equal to the population mean. Thirty three accessions had below average, 62 accessions had average, and five accessions and African Tall had above average mean for leaf-stem ratio. Among the stable genotypes, 62 accessions and African Tall were stable for all kind of environments. Maximum leaf-stem ratio was recorded in IC-335069 (0.62), which was stable for favourable

environments (bi = 503*) whereas African Tall had average mean performance (0.47) and was stable for all type of environments (bi = -0.22). Among the high or equal mean performance than population mean, 24 accessions were not found stable.

Crude protein content (%)

In case of crude protein content (Table 4.35) Simultaneous consideration of two-stability parameters, regression coefficient (bi) and sum of square deviation (S^2di) suggested the absence of G x E interaction in 54 accessions as the estimates of both these parameters were non- significant in such cases. Linear component was present for 42 accessions and African Tall as shown by significant regression coefficient. Only two accessions had both bi and S^2di significant, whereas, only one accession showed presence of non-linear component of stability.

Eighteen accessions had above average mean response, out of which 10 accessions were having mean values greater to population mean. Twenty four accessions showed below average response in which ten accessions were having mean values greater to the population mean and remaining 58 accessions and African Tall were average in response in which 28 accessions had their mean more or equal to the population mean that showed their suitability for favourable, unfavourable and general environments, respectively. Out of all accessions including African Tall, 32 accessions had above average mean, 65 accessions had average mean and five accessions and African Tall had below average mean than the population mean. Maximum crude protein content was observed in IC-334841 (12.24) and IC-334920 (12.12), which was stable in all kind of environments. Lowest crude protein content (%) was recorded in African Tall (8.66), which was below average in response (bi = 4.56*), therefore, it was stable for unfavourable environments. Among the accessions, three accessions namely IC-334836, IC-334880 and IC-335094 were found unstable.

Table 4.30 Estimation of stability parameters for leaf width.

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	7.81	1.93	-0.17	52.	IC- 335025	8.56	0.85*	-0.09
2.	IC- 334825	8.57	3.81*	0.25	53.	IC- 335027	8.44	-0.93*	-0.22
3.	IC- 334826	8.32	1.32	0.23	54.	IC- 335028	8.35	0.66*	-0.30
4.	IC- 334830	9.24	-1.79*	0.57	55.	IC- 335032	8.49	-0.75*	-0.08
5.	IC- 334833	9.40	-3.73*	0.90	56.	IC- 335035	8.41	-4.22*	-0.30
6.	IC- 334834	9.38	-0.53*	-0.28	57.	IC- 335041	9.04	-1.04*	0.40
7.	IC- 334836	9.13	-3.14*	-0.06	58.	IC- 335043	8.63	2.34	-0.04
8.	IC- 334837	9.44	-2.02*	-0.27	59.	IC- 335045	8.42	3.11*	-0.32
9.	IC- 334838	9.81	-0.19*	-0.27	60.	IC- 335048	8.36	0.73*	-0.22
10.	IC- 334841	9.57	-0.51*	-0.31	61.	IC- 335050	8.41	1.73	0.11
11.	IC- 334842	9.55	-0.14*	2.11	62.	IC- 335051	7.30	2.97	-0.31
12.	IC- 334846	9.94	-0.64*	0.06	63.	IC- 335053	9.24	1.61	0.02
13.	IC- 334848	9.13	1.90	-0.19	64.	IC- 335056	8.22	3.38*	1.96
14.	IC- 334853	8.39	-1.89*	-0.32	65.	IC- 335060	6.44	1.83	2.08
15.	IC- 334855	8.43	-3.07*	-0.29	66.	IC- 335062	7.08	0.06*	0.03
16.	IC- 334863	8.54	4.20*	-0.01	67.	IC- 335068	7.47	3.84*	0.31
17	IC- 334864	7.96	2.34	-0.04	68.	IC- 335069	7.83	1.97	1.00
18.	IC- 334867	8.37	-0.57*	-0.06	69.	IC- 335079	7.57	3.20*	0.46
19.	IC- 334869	9.13	2.61	1.75	70.	IC- 335082	7.68	3.06*	-0.18
20.	IC- 334871	8.74	0.06*	0.02	71.	IC- 335086	7.81	0.95*	1.14
21.	IC- 334872	8.69	-1.47*	-0.25	72.	IC- 335089	7.44	5.72*	-0.18
22.	IC- 334876	8.17	-2.73*	0.00	73.	IC- 335092	8.30	1.24	-0.24
23.	IC- 334877	7.91	-0.65*	-0.05	74.	IC- 335094	7.70	1.92	-0.10
24.	IC- 334879	8.48	-2.39*	-0.33	75.	IC- 335098	8.89	2.32	0.19
25.	IC- 334880	8.12	-0.57*	-0.33	76.	IC- 335103	8.54	2.74	1.21
26.	IC- 334881	8.93	1.22	-0.28	77.	IC- 335109	8.39	3.47*	0.98
27.	IC- 334884	8.30	0.65*	-0.33	78.	IC- 335110	8.54	-1.66*	1.47
28.	IC- 334889	7.59	-3.00*	-0.31	79.	IC- 335111	9.23	0.18*	2.29
29.	IC- 334904	8.69	2.23	-0.15	80.	IC- 335112	7.89	2.40	-0.32
30.	IC- 334915	8.80	0.95*	-0.07	81.	IC- 335115	8.42	-0.28*	0.42
31.	IC- 334920	8.16	-3.61*	0.13	82.	IC- 335116	7.67	1.63	2.43
32.	IC- 334929	8.23	-0.30*	-0.17	83.	IC- 335117	8.56	3.83*	-0.04
33.	IC- 334932	10.32	1.98	0.16	84.	IC- 335120	8.85	-1.97*	2.37
34.	IC- 334942	7.64	0.41*	-0.08	85.	IC- 335122	7.66	2.49	-0.19
35.	IC- 334943	8.67	-0.72*	-0.33	86.	IC- 335128	9.33	1.62	-0.27
36.	IC- 334944	8.57	1.18	0.29	87.	IC- 335131	8.24	0.89*	-0.33
37.	IC- 334945	9.14	0.33*	-0.23	88.	IC- 335138	7.66	4.37*	0.12
38.	IC- 334947	7.17	0.62*	1.32	89.	IC- 335141	7.61	0.19*	-0.31
39.	IC- 334949	8.68	0.75*	-0.32	90.	IC- 335144	8.59	2.58	-0.32
40.	IC- 334954	7.99	-2.05*	-0.30	91.	IC- 335148	8.00	2.55	-0.30
41.	IC- 334955	8.07	3.00*	-0.31	92.	IC- 335149	8.36	2.46	-0.23
42.	IC- 334957	7.80	-0.79*	2.36	93.	IC- 335152	8.58	1.05	-0.30
43.	IC- 334973	7.53	3.74*	3.47	94.	IC- 335156	8.63	0.78*	0.27
44.	IC- 334974	8.99	0.49*	-0.32	95.	IC- 335158	8.06	-1.59*	0.79
45.	IC- 334989	6.70	6.53*	3.06	96.	IC- 335164	8.16	0.07*	-0.32
46.	IC- 334996	7.69	4.55*	1.41	97.	IC- 335169	7.39	1.65	2.04
47.	IC- 334999	8.43	4.21*	-0.24	98.	IC- 335173	7.44	4.26*	-0.33
48.	IC- 335000	7.72	3.47*	0.98	99.	IC- 335178	8.31	3.00*	0.38
49.	IC- 335009	8.16	1.64	-0.20	100.	IC- 335184	8.45	3.95*	-0.22
50.	IC- 335017	8.03	4.63*	0.12	101.	African Tall	10.21	-0.82*	-0.30
51.	IC- 335024	8.14	0.33*	-0.23					

Table 4.31 Estimation of stability parameters for stem girth.

S. No.	Acc. No.	Mean	bi	S ²di	S. No	Acc. No.	Mean	bi	S ²di
1.	IC- 334821	1.85	1.82	-0.02	52.	IC- 335025	2.17	-0.40	0.01
2.	IC- 334825	2.05	0.23	0.00	53.	IC- 335027	2.14	1.24	0.12
3.	IC- 334826	2.23	0.99	0.16	54.	IC- 335028	1.99	1.68	-0.01
4.	IC- 334830	2.26	-0.65	0.01	55.	IC- 335032	2.12	0.09	0.10
5.	IC- 334833	2.36	0.09	-0.02	56.	IC- 335035	2.12	-0.17	0.35*
6.	IC- 334834	2.34	1.03	0.04	57.	IC- 335041	2.25	0.76	0.03
7.	IC- 334836	2.20	1.05	0.25*	58.	IC- 335043	1.99	1.42	-0.01
8.	IC- 334837	2.07	0.39	0.14	59.	IC- 335045	1.88	1.78	0.35*
9.	IC- 334838	2.31	1.98	0.02	60.	IC- 335048	2.13	1.79	-0.01
10.	IC- 334841	2.23	1.54	0.03	61.	IC- 335050	2.08	-1.14*	0.38*
11.	IC- 334842	2.28	3.17*	-0.02	62.	IC- 335051	1.82	1.42	-0.02
12.	IC- 334846	2.33	0.99	0.00	63.	IC- 335053	2.23	1.86	-0.02
13.	IC- 334848	2.37	3.58*	0.00	64.	IC- 335056	1.97	1.33	0.04
14.	IC- 334853	2.06	1.74	-0.02	65.	IC- 335060	1.54	3.10*	0.00
15.	IC- 334855	2.24	2.52	0.18	66.	IC- 335062	1.71	1.51	0.18
16.	IC- 334863	2.24	3.30*	0.25*	67.	IC- 335068	1.54	0.71	0.01
17	IC- 334864	2.17	0.05	0.01	68.	IC- 335069	1.86	1.15	-0.02
18.	IC- 334867	2.16	3.59*	-0.01	69.	IC- 335079	1.94	-0.35	0.00
19.	IC- 334869	2.20	2.46	-0.02	70.	IC- 335082	1.82	1.94	0.03
20.	IC- 334871	1.99	0.96	0.01	71.	IC- 335086	1.89	2.53	0.16
21.	IC- 334872	2.21	1.17	-0.01	72.	IC- 335089	1.89	0.08	0.44*
22.	IC- 334876	2.17	0.85	0.00	73.	IC- 335092	2.04	2.76*	-0.02
23.	IC- 334877	1.98	0.23	-0.02	74.	IC- 335094	1.90	-1.38*	0.00
24.	IC- 334879	2.04	-1.15*	0.02	75.	IC- 335098	1.89	1.15	0.07
25.	IC- 334880	2.08	-0.62	-0.02	76.	IC- 335103	2.02	-2.83*	0.00
26.	IC- 334881	2.02	0.62	0.00	77.	IC- 335109	2.15	0.23	0.06
27.	IC- 334884	2.14	-1.95*	0.09	78.	IC- 335110	2.11	1.03	0.04
28.	IC- 334889	1.80	1.33	0.00	79.	IC- 335111	2.01	2.36	-0.01
29.	IC- 334904	2.22	1.42	-0.02	80.	IC- 335112	1.97	1.86	-0.02
30.	IC- 334915	2.11	0.50	0.02	81.	IC- 335115	1.91	0.44	-0.02
31.	IC- 334920	1.97	0.65	-0.02	82.	IC- 335116	1.91	2.04	-0.02
32.	IC- 334929	1.98	1.77	-0.02	83.	IC- 335117	2.03	0.26	0.00
33.	IC- 334932	2.09	-0.71	0.00	84.	IC- 335120	1.98	2.84*	0.20
34.	IC- 334942	2.10	0.58	-0.01	85.	IC- 335122	1.82	1.15	-0.02
35.	IC- 334943	2.23	0.48	0.01	86.	IC- 335128	2.16	2.27	-0.02
36.	IC- 334944	1.94	-0.09	0.14	87.	IC- 335131	1.96	-0.44	0.00
37.	IC- 334945	2.33	-0.32	-0.01	88.	IC- 335138	1.97	0.58	-0.02
38.	IC- 334947	1.86	1.68	-0.02	89.	IC- 335141	1.94	-0.36	0.00
39.	IC- 334949	2.06	1.15	0.00	90.	IC- 335144	1.84	1.91	0.00
40.	IC- 334954	2.14	-0.20	-0.02	91.	IC- 335148	1.93	0.00	0.00
41.	IC- 334955	1.80	1.06	-0.01	92.	IC- 335149	2.01	3.41	0.03
42.	IC- 334957	2.03	3.67*	-0.02	93.	IC- 335152	1.83	0.26	0.10
43.	IC- 334973	1.88	3.10*	0.00	94.	IC- 335156	1.85	3.70*	0.02
44.	IC- 334974	2.10	0.80	0.02	95.	IC- 335158	1.98	2.83	-0.01
45.	IC- 334989	1.82	-0.50	0.07	96.	IC- 335164	1.86	1.68	0.00
46.	IC- 334996	1.84	0.44	0.14	97.	IC- 335169	1.81	2.30	-0.02
47.	IC- 334999	2.11	3.57*	0.07	98.	IC- 335173	1.79	0.88	0.16
48.	IC- 335000	2.15	-1.29*	-0.02	99.	IC- 335178	2.18	0.17	0.48**
49.	IC- 335009	2.08	-0.88*	-0.02	100.	IC- 335184	1.98	-0.12	0.33**
50.	IC- 335017	2.19	0.41	0.03	101.	African Tall	2.94	0.87	-0.02
51.	IC- 335024	2.16	-1.77*	-0.02					

Table 4.32 Estimation of stability parameters for green fodder yield/plant.

S. No.	Acc. No.	Mean	bi	S ^{2}di	S. No	Acc. No.	Mean	bi	S ^{2}di
1.	IC- 334821	367.96	-0.44*	9379.36**	52.	IC- 335025	498.53	0.00	7512.88**
2.	IC- 334825	543.94	0.56	21785.05**	53.	IC- 335027	567.92	0.43	6653.87*
3.	IC- 334826	591.48	3.56*	34.62	54.	IC- 335028	610.68	1.96*	4143.63*
4.	IC- 334830	694.94	0.71	24047.55**	55.	IC- 335032	664.67	0.97	52391.08**
5.	IC- 334833	782.04	2.14*	34353.89**	56.	IC- 335035	667.70	-1.50*	56408.61**
6.	IC- 334834	689.25	0.89	32704.53**	57.	IC- 335041	673.27	-1.20*	14084.88**
7.	IC- 334836	598.65	-1.67*	27622.04**	58.	IC- 335043	576.19	0.87	-214.86
8.	IC- 334837	609.50	-0.42*	18497.92**	59.	IC- 335045	532.11	0.88	15760.06**
9.	IC- 334838	687.40	1.19	38263.93**	60.	IC- 335048	600.01	0.80	8006.27**
10.	IC- 334841	690.18	-0.62	2684.20	61.	IC- 335050	585.46	1.58	6073.53*
11.	IC- 334842	683.44	0.95	25730.37**	62.	IC- 335051	449.02	0.53	1335.40
12.	IC- 334846	892.36	1.25	4414.54*	63.	IC- 335053	784.06	1.21	5535.27*
13.	IC- 334848	667.89	0.85	113383.06**	64.	IC- 335056	353.82	-0.15*	1818.55
14.	IC- 334853	544.46	1.41	8766.15	65.	IC- 335060	278.74	0.35	5088.95*
15.	IC- 334855	713.16	-0.77	-340.77*	66.	IC- 335062	357.59	-1.14*	712.36
16.	IC- 334863	618.07	2.56*	1727.56	67.	IC- 335068	208.83	0.11	-134.34
17	IC- 334864	633.24	3.32*	-41.17	68.	IC- 335069	399.73	-1.02*	14813.51**
18.	IC- 334867	585.14	2.29*	58.04	69.	IC- 335079	465.85	0.99	4101.10*
19.	IC- 334869	425.42	-0.77	17556.11**	70.	IC- 335082	418.89	2.87*	14596.20**
20.	IC- 334871	486.92	0.87	883.92	71.	IC- 335086	479.74	1.52	5090.64*
21.	IC- 334872	711.59	1.18	-345.20	72.	IC- 335089	565.32	3.92*	-257.79
22.	IC- 334876	551.78	0.96	28122.23**	73.	IC- 335092	575.33	-0.66*	32022.17**
23.	IC- 334877	495.48	1.53	2855.25	74.	IC- 335094	535.67	3.13*	2138.34
24.	IC- 334879	538.67	0.35	20303.97**	75.	IC- 335098	500.25	-0.83*	4739.97*
25.	IC- 334880	620.72	1.92	21080.63**	76.	IC- 335103	669.30	3.75*	58628.34**
26.	IC- 334881	555.41	2.44*	2056.82	77.	IC- 335109	628.61	1.94*	21408.87**
27.	IC- 334884	573.13	1.62	9385.43**	78.	IC- 335110	599.07	-1.31*	34843.68**
28.	IC- 334889	380.01	-0.16*	212.05	79.	IC- 335111	581.56	-0.52*	12956.53**
29.	IC- 334904	511.65	-0.17*	40400.57**	80.	IC- 335112	457.89	0.40	2499.74
30.	IC- 334915	678.93	1.76	-357.31	81.	IC- 335115	435.31	0.82	319.40
31.	IC- 334920	525.83	-0.11*	374.10	82.	IC- 335116	448.46	1.17	76.18
32.	IC- 334929	535.58	1.01	-132.95	83.	IC- 335117	528.83	1.79	5750.66*
33.	IC- 334932	543.53	2.04*	1844.42	84.	IC- 335120	536.69	-1.23*	606.96
34.	IC- 334942	598.55	0.75	-348.70	85.	IC- 335122	419.90	0.57	-350.78
35.	IC- 334943	697.40	3.41*	3432.72	86.	IC- 335128	562.68	0.02	16827.30**
36.	IC- 334944	420.44	1.91	-3.41	87.	IC- 335131	519.54	0.60	5964.91*
37.	IC- 334945	657.26	0.90	1238.90	88.	IC- 335138	537.86	0.84	-249.85
38.	IC- 334947	385.53	0.72	101.19	89.	IC- 335141	484.16	1.48	766.47
39.	IC- 334949	655.91	3.67*	-289.18	90.	IC- 335144	466.70	0.77	11091.75**
40.	IC- 334954	572.76	1.54	3636.38	91.	IC- 335148	617.85	2.58	92.99
41.	IC- 334955	504.31	2.14*	2984.02	92.	IC- 335149	565.06	1.38	19425.90**
42.	IC- 334957	468.15	-0.48*	11929.97**	93.	IC- 335152	572.61	1.31	5082.02*
43.	IC- 334973	515.27	0.53	1781.96	94.	IC- 335156	464.29	0.61	625.75
44.	IC- 334974	596.35	0.86	-318.92	95.	IC- 335158	513.65	-1.94*	61252.61**
45.	IC- 334989	487.98	3.67*	186.61	96.	IC- 335164	565.91	0.90	3732.99
46.	IC- 334996	517.18	3.24*	-186.72	97.	IC- 335169	444.73	0.85	80558.38**
47.	IC- 334999	682.71	1.65	50253.41**	98.	IC- 335173	488.79	2.29*	13636.95**
48.	IC- 335000	618.07	1.50	24457.13**	99.	IC- 335178	549.23	3.12*	11.88**
49.	IC- 335009	616.00	1.40	5772.95*	100.	IC- 335184	500.55	1.23	21363.97
50.	IC- 335017	700.07	1.39	15837.24**	101.	African Tall	1404.17	-0.77*	222.14
51.	IC- 335024	559.85	1.70	6907.69*					

able 4.33 Estimation of stability parameters for dry fodder yield.

S. No.	Acc. No.	Mean	bi	S ²di	S. No	Acc. No.	Mean	bi	S ²di
1.	IC- 334821	67.74	-0.28*	68.53	52.	IC- 335025	110.34	2.23*	148.79
2.	IC- 334825	105.66	2.15*	823.38**	53.	IC- 335027	104.54	1.03	89.63
3.	IC- 334826	94.09	2.59*	-16.28	54.	IC- 335028	105.51	1.38	75.42
4.	IC- 334830	115.17	1.49	1177.78**	55.	IC- 335032	101.82	-0.53*	1149.39**
5.	IC- 334833	130.57	2.10	251.19	56.	IC- 335035	91.92	-0.78*	1275.63**
6.	IC- 334834	120.74	0.33	264.28	57.	IC- 335041	105.47	-1.07*	936.14**
7.	IC- 334836	92.91	-0.80*	1725.23**	58.	IC- 335043	97.16	0.62	83.70
8.	IC- 334837	104.50	0.81	697.86**	59.	IC- 335045	85.84	0.63	382.43*
9.	IC- 334838	98.05	1.18	398.06*	60.	IC- 335048	104.40	1.31	4.49
10.	IC- 334841	106.13	1.37	116.73	61.	IC- 335050	102.78	0.92	67.00
11.	IC- 334842	112.03	0.96	137.21	62.	IC- 335051	70.60	-0.42	-24.73
12.	IC- 334846	128.21	0.86	230.52	63.	IC- 335053	113.31	-1.27*	1132.35**
13.	IC- 334848	106.50	1.25	1072.04**	64.	IC- 335056	65.41	-0.31	303.00*
14.	IC- 334853	98.13	0.70	23.18	65.	IC- 335060	47.91	-0.24*	-24.46
15.	IC- 334855	120.27	-1.23*	-5.93	66.	IC- 335062	81.33	-2.30*	-9.55
16.	IC- 334863	95.19	1.90*	-8.90	67.	IC- 335068	41.57	0.06	-2.51
17	IC- 334864	95.10	2.42*	35.41	68.	IC- 335069	58.70	-0.43*	347.64*
18.	IC- 334867	83.46	2.40*	-5.62	69.	IC- 335079	75.78	2.45*	305.92*
19.	IC- 334869	84.82	0.26	427.95*	70.	IC- 335082	79.35	1.56	409.44*
20.	IC- 334871	98.54	1.30	295.23*	71.	IC- 335086	82.29	2.56*	70.27
21.	IC- 334872	98.75	0.40	107.91	72.	IC- 335089	74.16	1.88*	771.29**
22.	IC- 334876	89.70	1.63	16.86	73.	IC- 335092	105.17	0.69	663.34**
23.	IC- 334877	88.05	1.77	-27.02	74.	IC- 335094	89.31	2.53*	-25.22
24.	IC- 334879	103.38	2.48*	765.19**	75.	IC- 335098	72.14	0.06	-21.36
25.	IC- 334880	96.51	1.57	282.76	76.	IC- 335103	95.47	2.70*	176.26
26.	IC- 334881	101.80	2.65*	-27.60	77.	IC- 335109	83.18	-0.04	614.78**
27.	IC- 334884	92.62	-0.02	-15.82	78.	IC- 335110	84.84	-0.49*	-16.98
28.	IC- 334889	55.73	-0.79*	-27.83	79.	IC- 335111	77.32	-0.98*	818.16**
29.	IC- 334904	76.79	-1.50*	179.12	80.	IC- 335112	73.20	0.31	195.63
30.	IC- 334915	111.94	1.00	209.73	81.	IC- 335115	85.27	1.94*	182.21
31.	IC- 334920	90.60	-0.10	223.73	82.	IC- 335116	76.63	2.09*	285.72
32.	IC- 334929	95.67	0.41	2014.28**	83.	IC- 335117	89.11	1.90*	16.10
33.	IC- 334932	97.15	2.23*	468.33*	84.	IC- 335120	78.74	0.22	95.51
34.	IC- 334942	118.61	2.36*	12.56	85.	IC- 335122	81.37	2.30*	41.72
35.	IC- 334943	108.00	2.31*	-6.54	86.	IC- 335128	99.60	1.09	925.39**
36.	IC- 334944	72.59	1.87*	-14.31	87.	IC- 335131	95.60	2.00*	-10.54
37.	IC- 334945	100.81	0.41	16.16	88.	IC- 335138	99.08	1.58	72.47
38.	IC- 334947	95.96	2.05*	140.93	89.	IC- 335141	84.64	3.20*	52.45
39.	IC- 334949	94.31	1.21	-16.42	90.	IC- 335144	66.66	0.24	15.55
40.	IC- 334954	95.91	1.75	-26.00	91.	IC- 335148	105.05	3.05*	413.24*
41.	IC- 334955	100.01	2.48*	791.79**	92.	IC- 335149	97.34	2.52*	841.49**
42.	IC- 334957	81.76	-1.21*	631.05**	93.	IC- 335152	109.11	0.97	132.16
43.	IC- 334973	76.80	-0.54*	199.57	94.	IC- 335156	79.53	0.93	84.77
44.	IC- 334974	81.24	0.23	36.83	95.	IC- 335158	95.45	-1.50*	398.85*
45.	IC- 334989	88.50	2.69*	352.23*	96.	IC- 335164	98.04	1.60	109.79
46.	IC- 334996	107.04	1.19	853.37**	97.	IC- 335169	77.07	1.31	1921.88**
47.	IC- 334999	106.84	0.70	1266.69**	98.	IC- 335173	83.94	2.47*	642.04**
48.	IC- 335000	113.59	1.36	1022.28**	99.	IC- 335178	91.52	1.56	566.71**
49.	IC- 335009	97.36	0.13	83.36	100.	IC- 335184	94.84	1.41	341.55*
50.	IC- 335017	99.38	0.43	222.74	101.	African Tall	170.29	0.18	65.15
51.	IC- 335024	104.40	2.95*	61.54					

Table 4.34 Estimation of stability parameters for leaf – stem ratio.

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	0.41	1.96	0.03**	52.	IC- 335025	0.31	2.00	0.01
2.	IC- 334825	0.23	0.87	0.00	53.	IC- 335027	0.37	1.58	0.00
3.	IC- 334826	0.37	2.12	0.00	54.	IC- 335028	0.33	1.64	0.01
4.	IC- 334830	0.35	0.81	0.00	55.	IC- 335032	0.44	1.70	0.01
5.	IC- 334833	0.39	0.84	0.01	56.	IC- 335035	0.48	1.82	0.02*
6.	IC- 334834	0.36	0.68	0.00	57.	IC- 335041	0.42	2.13	0.03**
7.	IC- 334836	0.49	0.32	0.03**	58.	IC- 335043	0.36	1.12	0.00
8.	IC- 334837	0.37	0.79	0.00	59.	IC- 335045	0.39	1.58	0.02*
9.	IC- 334838	0.33	-0.61	0.01	60.	IC- 335048	0.35	1.68	0.01
10.	IC- 334841	0.35	0.57	0.01	61.	IC- 335050	0.30	1.47	0.00
11.	IC- 334842	0.37	0.13	0.01	62.	IC- 335051	0.39	0.86	0.01
12.	IC- 334846	0.32	0.45	0.00	63.	IC- 335053	0.44	-0.44	0.00
13.	IC- 334848	0.37	0.48	0.00	64.	IC- 335056	0.46	2.06	0.05**
14.	IC- 334853	0.42	0.74	0.00	65.	IC- 335060	0.45	2.81*	0.05**
15.	IC- 334855	0.39	1.24	0.02*	66.	IC- 335062	0.44	2.23	0.05**
16.	IC- 334863	0.46	-0.54	0.00	67.	IC- 335068	0.62	5.03*	0.00
17	IC- 334864	0.38	1.66	0.01	68.	IC- 335069	0.48	0.26	0.05**
18.	IC- 334867	0.38	1.43	0.00	69.	IC- 335079	0.51	-1.48*	0.07**
19.	IC- 334869	0.46	1.79	0.00	70.	IC- 335082	0.42	1.43	0.00
20.	IC- 334871	0.42	0.63	0.00	71.	IC- 335086	0.33	1.15	0.01
21.	IC- 334872	0.44	-1.36*	0.00	72.	IC- 335089	0.44	0.69	0.00
22.	IC- 334876	0.40	0.79	0.02*	73.	IC- 335092	0.32	2.42*	0.00
23.	IC- 334877	0.40	1.43	0.01	74.	IC- 335094	0.39	1.75	0.01
24.	IC- 334879	0.33	-0.21	0.00	75.	IC- 335098	0.40	0.54	0.03**
25.	IC- 334880	0.39	0.27	0.00	76.	IC- 335103	0.42	0.54	0.00
26.	IC- 334881	0.44	-1.31*	0.03**	77.	IC- 335109	0.44	2.29*	0.05**
27.	IC- 334884	0.32	-0.02	0.01	78.	IC- 335110	0.53	-0.56	0.03**
28.	IC- 334889	0.55	1.24	0.01	79.	IC- 335111	0.42	0.19	0.00
29.	IC- 334904	0.46	0.57	0.03**	80.	IC- 335112	0.39	1.36	0.05**
30.	IC- 334915	0.33	1.46	0.00	81.	IC- 335115	0.36	1.72	0.03**
31.	IC- 334920	0.33	0.90	0.00	82.	IC- 335116	0.43	-1.04	0.05**
32.	IC- 334929	0.38	3.64*	0.03**	83.	IC- 335117	0.40	1.51	0.00
33.	IC- 334932	0.45	1.20	0.00	84.	IC- 335120	0.47	0.22	0.00
34.	IC- 334942	0.32	0.44	0.02	85.	IC- 335122	0.40	1.93	0.01
35.	IC- 334943	0.36	0.25	0.00	86.	IC- 335128	0.42	1.74	0.03**
36.	IC- 334944	0.41	0.13	0.00	87.	IC- 335131	0.55	-3.39*	0.06**
37.	IC- 334945	0.44	0.31	0.00	88.	IC- 335138	0.38	1.12	0.01
38.	IC- 334947	0.31	0.42	0.01	89.	IC- 335141	0.33	-0.37	0.01
39.	IC- 334949	0.45	0.61	0.00	90.	IC- 335144	0.52	2.93*	0.01
40.	IC- 334954	0.40	0.86	0.00	91.	IC- 335148	0.37	0.78	0.00
41.	IC- 334955	0.30	1.50	0.00	92.	IC- 335149	0.34	0.37	0.02*
42.	IC- 334957	0.43	1.00	0.01	93.	IC- 335152	0.30	1.82	0.00
43.	IC- 334973	0.46	2.32*	0.04**	94.	IC- 335156	0.46	0.68	0.02*
44.	IC- 334974	0.43	2.06	0.00	95.	IC- 335158	0.39	0.79	0.02*
45.	IC- 334989	0.29	0.97	0.01	96.	IC- 335164	0.30	0.55	0.00
46.	IC- 334996	0.28	1.86	0.00	97.	IC- 335169	0.38	0.72	0.02*
47.	IC- 334999	0.36	0.78	0.00	98.	IC- 335173	0.31	0.61	0.02*
48.	IC- 335000	0.29	0.57	0.00	99.	IC- 335178	0.37	2.52*	0.00
49.	IC- 335009	0.42	1.70	0.00	100.	IC- 335184	0.35	1.96	0.00
50.	IC- 335017	0.38	1.40	0.00	101.	African Tall	0.47	-0.22	0.00
51.	IC- 335024	0.33	2.08	0.01					

Table 4.35 **Estimation of stability parameters for crude protein content**

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	10.58	0.73	-0.10	52.	IC- 335025	11.33	-2.23*	0.08
2.	IC- 334825	11.20	3.44*	-0.10	53.	IC- 335027	10.76	0.91	0.20
3.	IC- 334826	11.42	4.71*	-0.13	54.	IC- 335028	10.45	1.01	-0.11
4.	IC- 334830	11.44	2.04	0.47	55.	IC- 335032	10.96	1.11	-0.10
5.	IC- 334833	11.43	2.31	-0.11	56.	IC- 335035	10.17	0.27	0.01
6.	IC- 334834	9.62	1.72	0.77	57.	IC- 335041	10.15	2.07	0.29
7.	IC- 334836	10.16	-0.35	3.43**	58.	IC- 335043	11.54	-1.57*	0.59
8.	IC- 334837	10.25	0.36	-0.05	59.	IC- 335045	10.39	-0.90*	-0.13
9.	IC- 334838	10.76	4.99*	0.02	60.	IC- 335048	9.77	1.52	0.86
10.	IC- 334841	12.24	3.17	-0.02	61.	IC- 335050	9.47	3.81*	-0.13
11.	IC- 334842	10.47	5.66*	0.04	62.	IC- 335051	11.64	2.23	0.47
12.	IC- 334846	10.50	6.74*	0.08	63.	IC- 335053	10.42	-2.31*	0.14
13.	IC- 334848	11.60	0.34	-0.13	64.	IC- 335056	10.45	-0.84*	0.30
14.	IC- 334853	11.46	1.03	-0.07	65.	IC- 335060	11.62	-2.72*	0.02
15.	IC- 334855	10.34	-0.56*	-0.11	66.	IC- 335062	11.02	-0.34	-0.10
16.	IC- 334863	10.15	4.29*	0.07	67.	IC- 335068	10.58	-0.67*	-0.12
17	IC- 334864	11.34	-2.32*	-0.04	68.	IC- 335069	10.63	0.12	0.08
18.	IC- 334867	10.43	3.60*	-0.03	69.	IC- 335079	10.49	-4.76*	1.17
19.	IC- 334869	11.11	1.28	0.02	70.	IC- 335082	11.10	4.03*	-0.13
20.	IC- 334871	9.02	-3.96*	0.64	71.	IC- 335086	11.41	0.44	-0.03
21.	IC- 334872	9.73	-4.03*	-0.09	72.	IC- 335089	11.02	-1.48*	-0.13
22.	IC- 334876	10.67	-0.16	-0.11	73.	IC- 335092	10.97	2.36	-0.10
23.	IC- 334877	10.48	2.37	-0.12	74.	IC- 335094	10.16	-2.06*	2.03*
24.	IC- 334879	10.95	2.03	-0.11	75.	IC- 335098	10.11	0.40	0.00
25.	IC- 334880	11.65	6.21*	6.07**	76.	IC- 335103	11.75	2.17	0.00
26.	IC- 334881	10.50	5.03*	0.14	77.	IC- 335109	11.09	0.53	-0.07
27.	IC- 334884	10.90	7.21*	0.13	78.	IC- 335110	10.89	1.61	0.01
28.	IC- 334889	11.77	3.28*	-0.12	79.	IC- 335111	10.17	-1.56*	0.09
29.	IC- 334904	11.97	6.90*	-0.12	80.	IC- 335112	10.48	-0.01	-0.12
30.	IC- 334915	11.25	4.38*	0.17	81.	IC- 335115	9.87	0.43	-0.12
31.	IC- 334920	12.12	1.39	0.02	82.	IC- 335116	11.28	1.79	-0.08
32.	IC- 334929	11.03	2.79*	0.15	83.	IC- 335117	11.21	0.33	-0.11
33.	IC- 334932	11.22	0.41	-0.09	84.	IC- 335120	10.77	-0.01	-0.08
34.	IC- 334942	11.53	2.19	-0.13	85.	IC- 335122	10.37	1.42	-0.10
35.	IC- 334943	10.55	6.20*	-0.08	86.	IC- 335128	10.66	1.28	0.14
36.	IC- 334944	11.43	2.67*	-0.07	87.	IC- 335131	10.91	-3.12*	0.14
37.	IC- 334945	10.19	0.38	-0.12	88.	IC- 335138	10.26	2.60*	0.27
38.	IC- 334947	10.80	-0.71*	-0.13	89.	IC- 335141	10.42	1.53	-0.01
39.	IC- 334949	10.15	-0.62*	0.42	90.	IC- 335144	11.12	-2.95*	1.03
40.	IC- 334954	10.94	-2.31*	0.00	91.	IC- 335148	11.99	-1.48*	0.18
41.	IC- 334955	10.64	0.42	0.08	92.	IC- 335149	10.69	-0.34	-0.10
42.	IC- 334957	10.62	1.15	0.15	93.	IC- 335152	10.60	-0.01	-0.03
43.	IC- 334973	10.33	3.06*	0.20	94.	IC- 335156	10.45	1.37	0.95
44.	IC- 334974	11.02	-0.05	1.26	95.	IC- 335158	10.10	2.48	0.47
45.	IC- 334989	10.75	0.01	0.38	96.	IC- 335164	10.90	1.43	-0.03
46.	IC- 334996	10.55	-0.76*	0.60	97.	IC- 335169	10.87	0.53	0.18
47.	IC- 334999	11.00	0.40	-0.11	98.	IC- 335173	10.26	-0.07	-0.07
48.	IC- 335000	10.62	2.18	0.54	99.	IC- 335178	11.11	1.84	0.18
49.	IC- 335009	10.44	1.87	0.51	100.	IC- 335184	10.00	3.73*	0.53
50.	IC- 335017	10.83	-0.53*	-0.12	101.	African Tall	8.66	-4.56*	0.87
51.	IC- 335024	10.48	-3.03*	-0.13					

Days to maturity

In case of days to maturity, both bi and S^2di values were non-significant for 54 accessions and African Tall indicating the absence of G x E interactions. Only two accessions had significant bi and S^2di revealing the presence of linear and non-linear components of G x E interactions. Five accession were having only significant bi values indicating the presence of linear component of G x E interactions, while 39 accessions had non-linear component of G x E interaction as they were having only S^2di values significant. (Table 4.36).

Out of 101 accessions including African Tall, most of the accessions (93 + African Tall) had bi approaching to unity (bi = 1) were found suitable for general environments. Out of these, 40 accessions and African Tall were having their mean performance more than population mean. Only six accessions had regression coefficient less than one showing their adaptability to unfavorable environments, out of which three accessions, namely IC-334920, IC-335103 and IC-335144 showed their mean more than the population mean. Only one accession (IC-335158) had its regression coefficient more than one (bi > 1), showing stable performance in favourable environment with low mean than the population mean. Seventy two accessions had below average days to maturity. African Tall showed very late maturity whereas 28 accessions were having average days to maturity.

Cob length (cm)

In case of cob length, both bi and S^2di values were non significant for 69 accessions and African Tall revealing the absence of G x E interactions. Sixteen accessions had significant bi value indicating the presence of linear components of G x E interaction. On the other hand 10 accessions had non-linear components of G x E interaction as they had significant S^2di values, whereas five accessions had both bi and S^2di values significant indicating the presence of linear and non-linear components of G x E interaction (Table 4.37).

10 accessions showed bi = < 1 indicating their stability for unfavorable/poor environments out of which two accessions, namely IC-

334877 and IC- 335128 showed their mean more than the population mean. 11 accessions were having > 1 bi value indicating their stability to favourable environments out of which 6 accessions namely, IC- (334989, 335035, 335082, 335112, 335141 and 335178) showed their mean more than the population mean. Remaining 79 accessions and African Tall were found suitable to all kind of environments as these were having bi values approaching to unity. Above average cob length was observed in five strains, namely African Tall and IC- (335024, 334996, 335111, and 335117) and their stability was estimated for all kind of environments as their response for bi approached to unity (bi = 1). Thirty five accessions were having below average cob length and 61 accessions were having average cob length.

Cob width (cm)

In case of cob width, out of 100 accessions and African Tall, 22 were significant for linear component and five were significant for non-linear component of G x E interaction, indicating that for most of the accessions, G x E was linear in nature suggesting that the prediction can be possible for cob width trait across the environments. Simultaneous consideration of bi and S^2di values revealed that 72 accessions and African Tall had non-significant values for these two parameters (Table 4.38). Only one accession had both bi and S^2di significant revealing the presence of both linear and non-linear components of G x E interaction.

Thirteen accessions had bi value greater than unity, out of which seven accessions had their mean values more than population mean and 10 accessions had bi values less than unity, in which five accessions were having their mean value more than population mean indicating their adaptability for favourable and poor environments, respectively. Remaining 77 accessions and African Tall showed their stability to general environments as they were having their bi values approaching to unity, out of which 36 accessions and African Tall were having their mean performance more than population mean. More than average cob width was observed in 18 accessions and African Tall, whereas, 61 accessions were average in cob width. However, below average cob width was recorded in 21 accessions. IC-

334932 had maximum cob width (3.90; bi=1.58) indicating its stability to all kind of environments, whereas IC-335032 having above average cob width (3.80; bi=2.88*) showed its stability to poor environment.

Number of kernel rows

In case of kernel rows/cob, simultaneous consideration of bi and S^2di values revealed that 83 accessions and African Tall had non-significant values for these two parameters (Table 4.38) indicating the absence of G x E interaction. None of the accessions were found significant for both bi and S^2di. 17 accessions had only linear components of G x E interaction as they had only significant bi whereas no accessions were found for non-linear component of G x E interaction as there was absence of significant S^2di values in all accessions (Table 4.39).

Eight accessions had bi > 1, out of which only three accessions had their mean more than population mean indicating their suitability to favourable environments. Nine accessions had bi < 1 in which only four accessions were having their mean more than population mean indicating their suitability to unfavourable environments. Eighty three accessions and African Tall had bi equal to unity showing their adaptability to general environments, out of which 36 accessions and African Tall had more mean than the population mean, out of 100 accessions and African Tall, 16 accessions and African Tall had above average, 69 accessions had average and remaining 15 accessions were below average in performance for number of kernel rows/cob. Maximum count of number of kernel rows/cob was recorded in IC-334944 (14.74) followed by IC-334947 (14.48) and IC-334942 (14.31). Among stable accessions, IC-334944, IC-334942, IC-334848 and IC-335060 were suited to all type of environments as they were having above average response and high mean values, whereas IC-334947, IC-335158 and IC-335079 had their adaptability to favourable environment as these accessions were having above average response and significant bi.

Table 4.36 Estimation of stability parameters for days to maturity.

S. No.	Acc. No.	Mean	bi	S ^{2}di	S. No.	Acc. No.	Mean	bi	S ^{2}di
1.	IC- 334821	79.89	1.96	-3.25	52.	IC- 335025	77.33	0.79	98.32**
2.	IC- 334825	81.33	0.81	-2.82	53.	IC- 335027	84.00	0.67	1.67
3.	IC- 334826	83.44	0.88	-1.22	54.	IC- 335028	76.78	1.09	7.88
4.	IC- 334830	88.22	1.36	26.30	55.	IC- 335032	80.00	1.19	19.24
5.	IC- 334833	89.33	1.68	27.81	56.	IC- 335035	86.00	1.86	-1.61
6.	IC- 334834	91.11	2.20	89.08**	57.	IC- 335041	82.11	0.13	103.20
7.	IC- 334836	86.89	1.29	7.65	58.	IC- 335043	73.78	1.16	29.89
8.	IC- 334837	86.33	1.40	-0.45	59.	IC- 335045	75.00	0.87	185.59
9.	IC- 334838	87.89	1.07	49.41*	60.	IC- 335048	81.67	0.92	17.09*
10.	IC- 334841	78.33	1.28	82.28**	61.	IC- 335050	79.00	0.07	86.10
11.	IC- 334842	87.44	1.63	13.99	62.	IC- 335051	78.56	-0.77*	143.36
12.	IC- 334846	89.44	1.59	64.97**	63.	IC- 335053	76.33	-1.51*	59.38
13.	IC- 334848	82.44	1.87	75.57**	64.	IC- 335056	72.22	0.35	21.14
14.	IC- 334853	90.78	2.39	38.52*	65.	IC- 335060	73.33	1.04	57.47*
15.	IC- 334855	88.78	1.40	43.76*	66.	IC- 335062	73.11	0.72	20.73*
16.	IC- 334863	89.89	1.45	42.47*	67.	IC- 335068	72.67	0.27	27.60**
17	IC- 334864	90.56	1.62	101.14**	68.	IC- 335069	70.33	1.56	-3.05*
18.	IC- 334867	90.78	2.38	4.12	69.	IC- 335079	75.67	1.68	49.29*
19.	IC- 334869	79.22	0.14	15.14	70.	IC- 335082	76.78	1.38	23.37
20.	IC- 334871	87.67	1.34	101.87	71.	IC- 335086	72.78	0.13	-1.71**
21.	IC- 334872	88.44	2.06	-3.12	72.	IC- 335089	75.00	1.06	13.14**
22.	IC- 334876	87.22	0.18	6.84	73.	IC- 335092	77.56	1.22	17.94*
23.	IC- 334877	87.44	-0.12	82.85**	74.	IC- 335094	76.33	0.11	77.94*
24.	IC- 334879	89.67	2.40	35.12*	75.	IC- 335098	73.56	1.50	76.32
25.	IC- 334880	86.56	1.97	-2.32	76.	IC- 335103	81.78	-0.54*	225.56
26.	IC- 334881	85.67	0.49	1.00	77.	IC- 335109	77.33	1.32	53.89*
27.	IC- 334884	86.89	0.43	41.82*	78.	IC- 335110	78.22	0.40	36.08*
28.	IC- 334889	82.78	0.82	18.85	79.	IC- 335111	70.00	0.45	25.90
29.	IC- 334904	94.11	1.50	63.70**	80.	IC- 335112	79.44	0.84	68.05
30.	IC- 334915	82.78	0.13	103.20**	81.	IC- 335115	84.11	1.09	269.79**
31.	IC- 334920	90.44	-1.44*	454.31**	82.	IC- 335116	75.44	1.64	51.83
32.	IC- 334929	79.33	1.68	-3.27	83.	IC- 335117	75.44	1.69	57.37*
33.	IC- 334932	80.11	2.31	278.25**	84.	IC- 335120	76.67	1.70	9.02
34.	IC- 334942	91.44	1.59	2.79	85.	IC- 335122	73.67	0.69	28.19*
35.	IC- 334943	91.89	1.77	13.84	86.	IC- 335128	77.44	2.12	40.20*
36.	IC- 334944	90.33	1.72	-1.14	87.	IC- 335131	76.11	1.76	44.39
37.	IC- 334945	93.78	1.45	92.66**	88.	IC- 335138	78.44	0.82	18.85
38.	IC- 334947	76.67	1.76	90.18**	89.	IC- 335141	77.78	1.69	0.67
39.	IC- 334949	88.22	1.03	27.74	90.	IC- 335144	83.33	-0.62*	89.52*
40.	IC- 334954	91.11	1.44	50.02*	91.	IC- 335148	81.33	0.98	13.93*
41.	IC- 334955	74.67	1.09	9.75	92.	IC- 335149	76.11	1.33	62.31
42.	IC- 334957	86.22	0.66	-0.16	93.	IC- 335152	79.89	0.92	-0.23
43.	IC- 334973	72.67	0.83	67.13**	94.	IC- 335156	86.67	-0.14	50.35
44.	IC- 334974	73.44	1.96	247.70**	95.	IC- 335158	77.00	2.46*	45.63
45.	IC- 334989	74.22	0.68	22.46	96.	IC- 335164	75.56	0.49	22.77
46.	IC- 334996	79.67	0.34	18.56	97.	IC- 335169	75.78	2.00	31.13
47.	IC- 334999	79.67	-0.95*	7.77	98.	IC- 335173	80.22	0.01	42.54
48.	IC- 335000	76.33	1.00	10.32	99.	IC- 335178	79.33	0.99	40.86
49.	IC- 335009	83.22	-0.23	29.55	100.	IC- 335184	74.11	0.20	-3.17
50.	IC- 335017	78.67	1.29	-3.24	101.	African Tall	119.33	-0.15	-2.39
51.	IC- 335024	80.22	-0.25	0.66					

Table 4.37 Estimation of stability parameters for cob length.

S. No.	Acc. No.	Mean	bi	S^2di	S. No.	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	14.72	2.87	0.81	52.	IC- 335025	16.93	7.81	1.67
2.	IC- 334825	15.14	1.61	-0.19	53.	IC- 335027	15.55	5.36	7.17
3.	IC- 334826	13.19	4.99	-1.22	54.	IC- 335028	16.91	12.16	15.09*
4.	IC- 334830	14.93	-4.17	13.90*	55.	IC- 335032	17.34	13.00	10.30
5.	IC- 334833	13.09	-9.59	-0.93	56.	IC- 335035	17.41	28.80*	-1.16
6.	IC- 334834	11.87	-0.67	23.64**	57.	IC- 335041	15.55	-12.96	5.07
7.	IC- 334836	15.61	-3.78	1.00	58.	IC- 335043	17.32	8.26	-1.19
8.	IC- 334837	12.76	-18.89*	-1.02	59.	IC- 335045	17.94	5.57	3.57
9.	IC- 334838	14.97	3.63	-1.03	60.	IC- 335048	17.11	4.31	0.00
10.	IC- 334841	14.65	12.79	0.51	61.	IC- 335050	17.80	-6.47	2.37
11.	IC- 334842	16.51	11.65	0.10	62.	IC- 335051	14.81	20.91*	-1.18
12.	IC- 334846	12.80	11.78	-1.07	63.	IC- 335053	16.92	4.90	-0.97
13.	IC- 334848	16.34	10.44	-1.10	64.	IC- 335056	14.50	13.37	-0.92
14.	IC- 334853	14.76	-12.79	1.31	65.	IC- 335060	13.14	-13.52	3.97
15.	IC- 334855	14.63	2.17	16.40*	66.	IC- 335062	13.26	-22.83*	10.39
16.	IC- 334863	15.76	-12.77	-0.86	67.	IC- 335068	12.38	15.77*	4.48
17	IC- 334864	15.61	-27.85*	3.15	68.	IC- 335069	15.05	0.22	-1.03
18.	IC- 334867	15.61	-15.72*	1.20	69.	IC- 335079	14.61	15.20	0.63
19.	IC- 334869	17.37	12.17	-1.22	70.	IC- 335082	16.97	22.88*	0.90
20.	IC- 334871	14.72	-7.99	7.44	71.	IC- 335086	15.39	-3.84	-0.78
21.	IC- 334872	13.67	5.37	3.06	72.	IC- 335089	15.22	24.77*	1.66
22.	IC- 334876	13.60	-8.46	-1.21	73.	IC- 335092	17.09	-1.82	3.23
23.	IC- 334877	15.87	-27.53*	20.29*	74.	IC- 335094	17.52	-3.86	-1.22
24.	IC- 334879	13.46	5.03	-1.21	75.	IC- 335098	17.20	-1.05	2.25
25.	IC- 334880	14.37	5.40	35.27**	76.	IC- 335103	17.59	13.38	0.25
26.	IC- 334881	12.86	11.21	2.20	77.	IC- 335109	17.02	-4.77	1.97
27.	IC- 334884	13.50	-1.84	11.40	78.	IC- 335110	18.37	0.86	0.17
28.	IC- 334889	13.48	-7.76	1.54	79.	IC- 335111	16.58	-3.88	-0.61
29.	IC- 334904	12.03	-10.59	4.47	80.	IC- 335112	17.46	20.71*	5.38
30.	IC- 334915	14.54	0.90	-1.16	81.	IC- 335115	17.14	1.78	1.13
31.	IC- 334920	13.74	-0.83	-1.19	82.	IC- 335116	15.15	1.10	6.11
32.	IC- 334929	16.69	-10.70	1.13	83.	IC- 335117	18.21	-7.35	-1.02
33.	IC- 334932	16.74	15.40	1.23	84.	IC- 335120	17.59	3.47	5.73
34.	IC- 334942	16.94	5.37	-1.13	85.	IC- 335122	16.47	11.52	-1.16
35.	IC- 334943	14.87	12.80	24.88**	86.	IC- 335128	16.22	-19.00*	12.59*
36.	IC- 334944	15.04	8.94	1.21	87.	IC- 335131	16.98	-8.90	1.84
37.	IC- 334945	14.37	13.44	2.40	88.	IC- 335138	14.58	-12.67	-1.19
38.	IC- 334947	13.53	-13.77*	-1.15	89.	IC- 335141	16.24	21.39*	22.70*
39.	IC- 334949	16.10	4.07	0.87	90.	IC- 335144	16.06	-10.56	21.87*
40.	IC- 334954	13.83	2.66	-0.16	91.	IC- 335148	17.02	-3.10	0.38
41.	IC- 334955	15.75	7.41	0.53	92.	IC- 335149	15.58	24.43*	6.55
42.	IC- 334957	15.65	-29.48*	-1.06	93.	IC- 335152	15.35	-16.96*	0.72
43.	IC- 334973	14.90	-11.38	21.10*	94.	IC- 335156	16.39	-1.67	0.13
44.	IC- 334974	14.57	-9.20	14.72*	95.	IC- 335158	17.80	20.10*	0.31
45.	IC- 334989	16.19	16.29*	16.95*	96.	IC- 335164	16.15	-1.01	-0.29
46.	IC- 334996	19.44	11.03	-0.25	97.	IC- 335169	15.30	2.80	-0.23
47.	IC- 334999	17.76	0.21	-1.20	98.	IC- 335173	16.52	-2.80	-0.82
48.	IC- 335000	16.76	-13.34	20.45*	99.	IC- 335178	16.45	21.66*	12.67*
49.	IC- 335009	17.81	-5.47	-1.22	100.	IC- 335184	16.48	2.66	4.88
50.	IC- 335017	15.52	-18.39*	-0.40	101.	African Tall	21.34	-4.92	1.47
51.	IC- 335024	19.81	-1.79	3.56					

Table 4.38 Estimation of stability parameters for cob width.

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	3.70	-0.50	0.44*	52.	IC- 335025	3.50	0.33	0.14
2.	IC- 334825	3.48	0.32	-0.03	53.	IC- 335027	3.79	1.19	-0.03
3.	IC- 334826	3.16	1.35	0.02	54.	IC- 335028	3.31	1.60	-0.01
4.	IC- 334830	3.20	1.00	-0.02	55.	IC- 335032	3.80	2.88*	0.04
5.	IC- 334833	3.24	1.91	-0.01	56.	IC- 335035	3.59	0.59	0.02
6.	IC- 334834	3.06	3.14*	0.14	57.	IC- 335041	3.61	-0.98*	0.20
7.	IC- 334836	3.44	-0.79	-0.01	58.	IC- 335043	3.55	2.34	0.08
8.	IC- 334837	3.30	1.27	0.03	59.	IC- 335045	3.46	-1.65*	0.05
9.	IC- 334838	3.49	1.44	0.08	60.	IC- 335048	3.69	-0.56	-0.03
10.	IC- 334841	3.64	0.98	0.11	61.	IC- 335050	3.60	-0.18	0.00
11.	IC- 334842	3.73	0.94	-0.01	62.	IC- 335051	3.52	3.60*	-0.02
12.	IC- 334846	3.37	1.61	0.03	63.	IC- 335053	3.38	1.18	0.01
13.	IC- 334848	3.70	1.95	-0.01	64.	IC- 335056	3.37	2.72*	-0.02
14.	IC- 334853	3.70	-0.32	-0.03	65.	IC- 335060	3.46	2.06	0.00
15.	IC- 334855	3.42	1.63	0.01	66.	IC- 335062	3.24	-0.39	-0.02
16.	IC- 334863	3.43	-1.83*	-0.01	67.	IC- 335068	3.56	0.93	0.05
17	IC- 334864	3.37	-0.98*	0.23	68.	IC- 335069	3.41	0.29	0.02
18.	IC- 334867	3.20	1.21	0.02	69.	IC- 335079	3.49	1.43	-0.03
19.	IC- 334869	3.63	1.76	0.04	70.	IC- 335082	3.67	1.86	-0.01
20.	IC- 334871	3.48	2.84*	0.23	71.	IC- 335086	3.36	2.58*	0.14
21.	IC- 334872	3.46	0.77	0.46*	72.	IC- 335089	3.43	2.33	0.06
22.	IC- 334876	3.42	1.93	0.01	73.	IC- 335092	3.45	0.53	0.03
23.	IC- 334877	3.84	-0.22	-0.02	74.	IC- 335094	3.61	1.49	0.24
24.	IC- 334879	3.53	1.37	0.07	75.	IC- 335098	3.33	2.35	0.12
25.	IC- 334880	3.54	4.45*	0.05	76.	IC- 335103	3.30	0.27	0.00
26.	IC- 334881	3.32	1.59	0.18	77.	IC- 335109	3.37	0.74	0.11
27.	IC- 334884	3.54	-1.78*	0.17	78.	IC- 335110	3.13	0.02	-0.02
28.	IC- 334889	3.09	0.70	-0.02	79.	IC- 335111	3.53	1.11	0.10
29.	IC- 334904	3.54	0.97	-0.01	80.	IC- 335112	3.38	3.12*	-0.02
30.	IC- 334915	3.37	2.14	0.07	81.	IC- 335115	3.18	0.24	0.07
31.	IC- 334920	3.18	-0.48	-0.02	82.	IC- 335116	3.60	2.65*	-0.01
32.	IC- 334929	3.40	-0.56	-0.02	83.	IC- 335117	3.51	0.65	0.09
33.	IC- 334932	3.90	1.58	-0.02	84.	IC- 335120	3.40	0.86	0.04
34.	IC- 334942	3.63	0.40	1.09**	85.	IC- 335122	3.40	0.39	-0.02
35.	IC- 334943	3.57	0.46	-0.02	86.	IC- 335128	3.55	0.41	0.03
36.	IC- 334944	3.76	0.37	0.27	87.	IC- 335131	3.45	1.11	0.18
37.	IC- 334945	3.46	3.17*	0.00	88.	IC- 335138	3.23	-0.59*	0.21
38.	IC- 334947	3.62	2.86*	0.00	89.	IC- 335141	3.29	1.40	0.01
39.	IC- 334949	3.60	1.27	0.04	90.	IC- 335144	3.52	0.42	0.07
40.	IC- 334954	3.39	2.36	-0.03	91.	IC- 335148	3.40	2.52	0.01
41.	IC- 334955	3.33	-1.02*	1.40**	92.	IC- 335149	3.08	2.45	-0.02
42.	IC- 334957	3.35	0.00	0.04	93.	IC- 335152	3.68	0.96	0.02
43.	IC- 334973	3.59	3.59*	-0.01	94.	IC- 335156	3.48	-0.43	0.10
44.	IC- 334974	3.57	2.54	0.41*	95.	IC- 335158	3.46	2.65*	0.04
45.	IC- 334989	3.43	0.06	0.29*	96.	IC- 335164	3.34	0.09	-0.03
46.	IC- 334996	3.69	0.13	-0.02	97.	IC- 335169	3.27	1.14	0.01
47.	IC- 334999	3.77	-1.33*	0.10	98.	IC- 335173	3.43	-0.97*	-0.01
48.	IC- 335000	3.63	-0.12	-0.03	99.	IC- 335178	3.48	1.42	0.11
49.	IC- 335009	3.74	-1.13*	0.07	100.	IC- 335184	3.40	1.28	0.23
50.	IC- 335017	3.65	1.77	-0.02	101.	African Tall	3.71	1.02	0.03
51.	IC- 335024	3.79	0.74	0.28					

Table 4.39 **Estimation of stability parameters for number of kernel rows.**

S. No.	Acc. No.	Mean	bi	S ^{2}di	S. No	Acc. No.	Mean	bi	S ^{2}di
1.	IC- 334821	13.39	-0.44	1.02	52.	IC- 335025	12.55	0.84	-0.62
2.	IC- 334825	13.04	0.09	0.62	53.	IC- 335027	13.26	0.04	-0.61
3.	IC- 334826	12.63	2.02	-0.63	54.	IC- 335028	12.30	2.31	0.46
4.	IC- 334830	11.37	0.52	-0.08	55.	IC- 335032	12.91	2.41	0.46
5.	IC- 334833	10.22	1.41	-0.58	56.	IC- 335035	13.17	0.75	1.41
6.	IC- 334834	11.30	1.62	0.31	57.	IC- 335041	13.59	0.03	0.48
7.	IC- 334836	11.07	-0.90*	0.64	58.	IC- 335043	12.15	2.03	-0.28
8.	IC- 334837	10.96	1.41	-0.46	59.	IC- 335045	12.36	1.16	3.52
9.	IC- 334838	11.26	0.82	2.29	60.	IC- 335048	11.85	0.31	0.08
10.	IC- 334841	12.18	-2.11*	-0.30	61.	IC- 335050	13.65	0.60	-0.66
11.	IC- 334842	12.37	1.01	-0.54	62.	IC- 335051	11.85	2.82*	-0.64
12.	IC- 334846	11.26	1.42	0.15	63.	IC- 335053	12.30	1.30	0.44
13.	IC- 334848	14.26	1.33	3.85	64.	IC- 335056	12.11	0.60	0.01
14.	IC- 334853	11.96	-0.38	2.64	65.	IC- 335060	14.09	0.53	-0.04
15.	IC- 334855	12.00	0.99	2.02	66.	IC- 335062	13.24	2.14	1.68
16.	IC- 334863	12.11	-1.29*	4.73	67.	IC- 335068	13.74	1.33	4.26
17	IC- 334864	11.15	1.12	0.41	68.	IC- 335069	12.96	-0.41	-0.53
18.	IC- 334867	10.00	-0.60*	0.01	69.	IC- 335079	13.81	-0.70*	-0.61
19.	IC- 334869	11.07	0.89	1.08	70.	IC- 335082	12.98	0.70	-0.63
20.	IC- 334871	11.67	3.24*	1.13	71.	IC- 335086	12.70	0.69	0.09
21.	IC- 334872	12.86	1.57	4.17	72.	IC- 335089	12.20	1.01	5.90
22.	IC- 334876	12.05	2.53	2.26	73.	IC- 335092	11.81	0.27	5.46
23.	IC- 334877	12.00	1.23	1.98	74.	IC- 335094	11.65	0.58	3.15
24.	IC- 334879	12.52	0.61	-0.63	75.	IC- 335098	11.87	1.70	0.95
25.	IC- 334880	11.86	3.04*	1.54	76.	IC- 335103	11.72	-2.01*	-0.49
26.	IC- 334881	11.70	0.96	3.68	77.	IC- 335109	12.15	0.60	-0.13
27.	IC- 334884	11.96	0.18	3.32	78.	IC- 335110	12.32	0.50	-0.63
28.	IC- 334889	10.25	0.57	-0.15	79.	IC- 335111	12.89	1.20	0.54
29.	IC- 334904	13.18	1.30	-0.40	80.	IC- 335112	11.85	1.42	0.31
30.	IC- 334915	11.48	2.02	-0.27	81.	IC- 335115	11.81	1.32	0.41
31.	IC- 334920	12.52	1.22	0.32	82.	IC- 335116	12.70	2.42	-0.66
32.	IC- 334929	12.78	0.11	1.58	83.	IC- 335117	12.33	0.10	-0.50
33.	IC- 334932	13.37	-0.50	-0.06	84.	IC- 335120	11.71	0.69	3.13
34.	IC- 334942	14.31	1.26	3.60	85.	IC- 335122	11.96	2.41	-0.24
35.	IC- 334943	11.41	1.22	1.70	86.	IC- 335128	12.32	2.34	0.40
36.	IC- 334944	14.74	1.15	-0.66	87.	IC- 335131	11.46	0.25	-0.66
37.	IC- 334945	12.89	2.41	0.56	88.	IC- 335138	11.68	-0.05	-0.23
38.	IC- 334947	14.48	4.13*	-0.62	89.	IC- 335141	10.97	-0.49	1.40
39.	IC- 334949	12.53	1.93	1.14	90.	IC- 335144	13.17	1.29	4.06
40.	IC- 334954	12.47	5.00*	1.01	91.	IC- 335148	11.59	0.69	0.09
41.	IC- 334955	11.96	1.93	2.11	92.	IC- 335149	11.74	3.41*	0.78
42.	IC- 334957	11.78	0.10	-0.50	93.	IC- 335152	12.96	1.08	6.54
43.	IC- 334973	13.30	1.31	-0.61	94.	IC- 335156	12.19	0.10	-0.66
44.	IC- 334974	12.33	4.11*	2.56	95.	IC- 335158	14.26	3.02*	-0.62
45.	IC- 334989	12.93	-1.12*	0.61	96.	IC- 335164	12.29	-0.47	-0.58
46.	IC- 334996	12.13	0.73	4.94	97.	IC- 335169	11.85	1 30	-0.41
47.	IC- 334999	12.15	0.55	-0.17	98.	IC- 335173	13.03	-1.04*	0.30
48.	IC- 335000	12.46	-0.90*	-0.13	99.	IC- 335178	12.73	-0.53	-0.29
49.	IC- 335009	13.48	1.01	-0.27	100.	IC- 335184	12.04	2.30	2.20
50.	IC- 335017	12.52	1.92	-0.57	101.	African Tall	13.17	0.57	-0.62
51.	IC- 335024	12.53	1.71	2.31					

Number of kernels/row

Eighty three accessions and African Tall showed absence of G x E interaction when the non- significance of bi and S^2di was considered together (table 4.40). The presence of only linear portion of G x E interaction was recorded for 12 accessions. No accessions were having both the linear and non- linear portion, whereas for five accessions only non- linear portion was significant.

Considering regression coefficient values, 12 accessions had bi > 1, thus these could be exploited in favorable environments for more number of kernels/row. No accession was having below average response (bi < 1) showing absence of suitability towards the unfavourable environments. Eighty eight accessions and African Tall showed regression coefficient equal to unity (bi = 1). Out of 100 accessions and African Tall, 23 accessions had below average number of kernels/row, forty seven accessions average, whereas 30 accessions and African Tall were above average in number of kernels/row. IC-335094 (40.42), IC-335120 and African Tall (39.26) were rich in number of kernels/row with average response (bi = 0.620, -2.03, -0.93, respectively) and were stable for general environments. Out of 100 accessions only five accessions namely IC-334825, IC-334973, IC-334974, IC-335035 and IC-335149 were found unstable. IC-335110 followed by IC-335028, IC-338164 and IC-335024 were above average in response with high mean than the population mean.

Shank diameter (cm)

Simultaneous consideration of two stability parameters bi and S^2di revealed that 67 accessions and African Tall showed absence of G x E interaction as both bi and S^2di were non-significant (Table 4.41). Two accessions had significant S^2di that showed the presence of non-linear component. Thirty two accessions had significant bi and having linear components of G x E interaction. No accessions were having both bi and S^2di values significant for shank diameter.

Ninety eight accessions and African Tall were found stable as these were having non-significant S^2di values. Eighteen accessions had > 1 bi,

twelve accessions < 1 bi and 70 accessions and African Tall had bi = 1 indicating their stability to good, poor and medium environment, respectively. Out of 101 accessions along with African Tall, 34 accessions had below average, 58 accessions average and remaining eight accessions and African Tall were above average in performance for shank diameter. Most thick shank was recorded for African Tall (1.62) followed by IC-334996 (1.59) and IC-335025 (1.53). Among stable accessions, IC-335025, IC-335131 and IC-335045 were suited for general environments as these were having average response and high mean, whereas accessions like IC-335116, IC-334974, IC-335043, IC-335045, IC-335048, IC-335053, IC-335051, IC-335141, IC-335112 and IC-335096 had less adaptability to favourable environments with high mean. IC-335156, IC-335144, IC-334999, IC-335050, IC-334955, IC-335128 and IC-335110 were stable in poor environments with high mean than population mean. Accession IC-334973 exhibited high mean but was unstable. Other unstable accession with poor mean was IC-334864.

Kernel length (cm)

In case of kernel length (Table 4.42), both bi and S^2di values were non-significant for 68 accessions and African Tall showing the absence of G x E interaction. Only one accession had both bi and S^2di values significant. 29 accessions showed linear components of G x E interaction whereas two accessions had non-linear components.

Seventeen accessions had bi > 1, 12 accession bi < 1 and 72 accessions including African Tall had bi approaching to unity indicating their suitability to good, poor and medium environments, respectively. Accessions like IC- (334974 followed by 334848, 334855, 334871, 334915 and 334949) showed adaptability to favourable environment with greater or equal mean than the population mean, whereas accessions like IC- (334841 followed by 334867, 334879, 334884, 335045 and 335028) below average response with greater or equal to population mean. Maximum kernel length was observed in accessions like IC- (334954 followed by 334853 and 334932). Among the 100 accessions only three accessions namely IC- (334821, 334955 and 334989) were found unstable.

Kernel width (cm)

Simultaneous consideration of two stability parameters bi and S^2di suggested the absence of G x E interaction in 68 accessions and African Tall as the estimates of these parameters were non-significant in their cases. Linear components were exhibited by 29 accessions as shown by significant bi values (Table 4.43). Only one accession had significant bi and S^2di indicating the presence of linear as well as non-linear components of G x E interaction, whereas only two accessions had significant non-linear components.

Sixteen accessions had above average response (bi > 1), 14 accessions had below average response (bi < 1) and 70 accessions with African Tall had average response (bi = 1) showed their adaptability to favourable, unfavourable and medium environments, respectively. Eight accessions namely IC- (334846 followed by 335092, 334880, 334871, 334855, 335098, 334830 and 335089) were showing stability for good environment with high mean or equal to the population mean. Ten accessions, namely IC- 334954 followed by IC- (335045, 335024, 334881, 334884, 334996, 335152, 334999, 335122 and 334929) showed suitability to poor environments as their regression coefficients were below average and mean below or equal to the population mean. Among the 100 accessions and African Tall, only three accessions, namely IC- 334877, IC- 334955 and IC-334989 were found unstable. Maximum kernel width was recorded for IC-334869 followed by IC- 334846 and IC- 334932. IC- 334846 was found stable for good environments.

Test weight (100 seed) (g)

In case of 100 seed weight, both regression coefficient and mean sum of squares due to deviations were non-significant for 48 accessions including African Tall indicating the G x E interaction. Eighteen accessions having significant regression coefficient (bi) showed the presence of linear components of G x E interaction. Only seven accessions showed presence of linear and non-linear components of G x E interaction as they were having

both bi and S^2di significant. Twenty eight accessions showed significant S^2di values indicating the presence of non-linear components of G x E interaction. (Table 4.44).

Fourteen accessions were having > 1 bi values, out of which four accessions namely IC-334869. IC-334929, IC-334877 and IC-334943 had their mean more than the population mean, indicating their adaptability to favourable environments. 12 accessions had < 1 bi value in which four accessions namely IC-334853, IC-335024, IC-335025 and IC-334864 had their mean more than the population means showing their suitability to unfavourable/poor environments. Seventy four accessions and African Tall were suitable to general environments as they were having bi values approaching to unity, out of which 41 accessions and African Tall reflected their mean more than the population mean. For test weight, 59 accessions showed average mean and 19 accessions less while 22 accessions and African Tall showed more than average mean performance among high yielding and stable genotypes. Out of 22 accessions and African Tall, African Tall and 11 accessions, namely IC-334932 followed by IC-334871, IC-334841, IC-334863, IC-334884, IC-334834, IC-334867, IC-334957, IC-334842, IC-335092 and IC-335116 were found stable in favourable environments while IC-334876 was stable in unfavourable environment for 100 seed weight.

Seed yield/plant (g)

Forty six accessions and African Tall had non-significant bi and S^2di values indicating absence of G x E interaction and eleven accessions had significant bi and S^2di values revealing the presence of linear and non-linear components of G x E interactions. 28 accessions had linear component of G x E interaction whereas 15 accessions had non-linear component of G x E interaction, as S^2di alone was significant in case of these accessions (Table 4.45).

Twenty accessions had bi values more than unity, out of which 11 accessions had their mean more than the population mean.19 accessions were having less than unity regression coefficient (bi) values, in which 14

accessions had their mean more than population mean. 61 accessions and African Tall were having bi values approaching to unity, out of which 16 accessions were having their mean performance more than population mean indicating their stability to favourable, unfavourable and all kinds of environments. Out of 101 accessions, 13 accessions including African Tall had above average seed yield/plant, 38 accessions had below average seed yield/plant and remaining 50 accessions were average in seed yield/plant. African Tall had maximum seed yield/plant (261.61g) followed by IC-335024 (260.64g), whereas IC-334904 showed minimum seed yield/plant. Out of 45 stable accessions and African Tall, above average seed yield/plant was exhibited by African Tall and eight accessions, namely IC-334848 followed by IC-334825, IC-334869, IC-335173, IC-334942, IC-335053, IC-335092 and IC-335103, indicating their adaptability to all kind of environments with high seed yield/plant.

Table 4.40 **Estimation of stability parameters for number of kernels/row.**

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	26.19	-0.57	39.94	52.	IC- 335025	31.63	-1.40	-1.30
2.	IC- 334825	30.78	-1.83	164.40*	53.	IC- 335027	37.83	2.34	77.09
3.	IC- 334826	28.78	-0.75	17.27	54.	IC- 335028	33.63	3.48*	-7.41
4.	IC- 334830	22.87	2.36	-9.82	55.	IC- 335032	36.33	-1.08	-7.95
5.	IC- 334833	25.81	1.87	43.92	56.	IC- 335035	38.39	-0.04	158.82*
6.	IC- 334834	23.11	-1.82	20.23	57.	IC- 335041	31.44	1.66	-6.54
7.	IC- 334836	28.44	-1.12	44.26	58.	IC- 335043	36.89	1.21	-0.95
8.	IC- 334837	25.85	-1.93	-6.74	59.	IC- 335045	27.15	3.86*	43.30
9.	IC- 334838	31.22	-2.12	103.55	60.	IC- 335048	28.55	1.04	12.54
10.	IC- 334841	22.11	-2.13	3.43	61.	IC- 335050	35.33	-0.86	-5.90
11.	IC- 334842	27.45	4.26*	35.53	62.	IC- 335051	26.44	-3.03	101.56
12.	IC- 334846	25.87	1.98	6.86	63.	IC- 335053	35.07	0.24	12.30
13.	IC- 334848	31.70	2.98	-2.33	64.	IC- 335056	30.22	-0.53	0.14
14.	IC- 334853	26.18	0.48	27.10	65.	IC- 335060	25.74	4.84*	-9.86
15.	IC- 334855	21.83	-0.36	-8.00	66.	IC- 335062	28.41	3.18	44.01
16.	IC- 334863	27.63	3.75*	-9.04	67.	IC- 335068	27.59	0.63	29.68
17	IC- 334864	29.04	1.72	-9.76	68.	IC- 335069	28.48	2.64	-8.80
18.	IC- 334867	27.83	-1.21	83.25	69.	IC- 335079	32.20	0.55	21.99
19.	IC- 334869	33.70	-0.95	-2.68	70.	IC- 335082	36.07	-1.91	-9.88
20.	IC- 334871	20.79	-2.46	77.38	71.	IC- 335086	32.07	1.53	-9.74
21.	IC- 334872	20.61	-1.67	-0.19	72.	IC- 335089	29.56	0.25	2.44
22.	IC- 334876	24.04	-2.10	35.38	73.	IC- 335092	33.81	0.31	39.02
23.	IC- 334877	29.04	4.25*	77.15	74.	IC- 335094	40.42	0.62	-6.10
24.	IC- 334879	29.30	-0.51	6.57	75.	IC- 335098	36.59	2.03	-9.33
25.	IC- 334880	23.67	-2.38	33.59	76.	IC- 335103	30.01	2.74	6.00
26.	IC- 334881	24.50	-0.44	-7.44	77.	IC- 335109	38.37	2.68	16.66
27.	IC- 334884	22.67	1.82	-9.05	78.	IC- 335110	37.22	4.93*	9.98
28.	IC- 334889	24.18	1.97	39.66	79.	IC- 335111	37.29	3.17	5.94
29.	IC- 334904	19.59	-0.07	39.52	80.	IC- 335112	35.52	2.47	10.90
30.	IC- 334915	29.89	-0.67	-4.67	81.	IC- 335115	36.43	0.34	-5.95
31.	IC- 334920	26.67	0.43	-2.89	82.	IC- 335116	34.22	1.80	-9.63
32.	IC- 334929	27.70	5.02*	36.69	83.	IC- 335117	39.00	0.60	-2.89
33.	IC- 334932	28.11	5.76*	69.64	84.	IC- 335120	40.30	-2.03	-3.38
34.	IC- 334942	28.26	1.70	1.21	85.	IC- 335122	34.48	1.29	-8.91
35.	IC- 334943	25.96	1.87	6.67	86.	IC- 335128	33.11	4.09	-9.78
36.	IC- 334944	29.56	1.35	1.05	87.	IC- 335131	36.96	0.53	-9.51
37.	IC- 334945	25.93	-1.02	-1.95	88.	IC- 335138	34.00	0.59	0.45
38.	IC- 334947	28.44	3.06	47.46	89.	IC- 335141	27.85	6.59*	73.50
39.	IC- 334949	28.07	2.73	-0.29	90.	IC- 335144	32.44	1.34	26.50
40.	IC- 334954	20.37	-1.50	-9.45	91.	IC- 335148	36.74	1.88	-9.49
41.	IC- 334955	29.70	1.22	-6.66	92.	IC- 335149	33.37	0.95	111.95*
42.	IC- 334957	25.56	1.66	95.40	93.	IC- 335152	32.68	3.03	11.91
43.	IC- 334973	30.15	-0.63	283.44**	94.	IC- 335156	30.63	1.87	18.78
44.	IC- 334974	30.28	-1.58	166.29*	95.	IC- 335158	39.26	1.02	-7.06
45.	IC- 334989	29.81	0.95	-6.34	96.	IC- 335164	32.70	4.49*	-8.69
46.	IC- 334996	37.15	2.22	6.96	97.	IC- 335169	34.57	2.99	16.38
47.	IC- 334999	37.07	-1.63	-6.48	98.	IC- 335173	38.37	1.26	17.74
48.	IC- 335000	33.19	0.48	103.75	99.	IC- 335178	35.85	-2.01	-2.57
49.	IC- 335009	29.63	0.94	39.63	100.	IC- 335184	32.89	0.91	17.21
50.	IC- 335017	32.26	1.13	58.95	101.	African Tall	39.26	-0.93	-4.72
51.	IC- 335024	30.96	6.38*	22.90					

Table 4.41 Estimation of stability parameters for shank diameter.

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	1.16	-2.54	0.03	52.	IC- 335025	1.48	-2.43	-0.02
2.	IC- 334825	1.37	-0.30	0.01	53.	IC- 335027	1.24	6.40*	-0.01
3.	IC- 334826	1.13	-1.68	0.01	54.	IC- 335028	1.22	-1.70	0.00
4.	IC- 334830	1.17	4.45	0.03	55.	IC- 335032	1.34	2.67	-0.01
5.	IC- 334833	1.01	0.87	0.03	56.	IC- 335035	1.23	1.36	0.00
6.	IC- 334834	1.10	7.47*	-0.02	57.	IC- 335041	1.30	-0.77	-0.02
7.	IC- 334836	1.35	-2.53	0.12	58.	IC- 335043	1.43	9.28*	0.08
8.	IC- 334837	1.10	-2.32	-0.02	59.	IC- 335045	1.42	1.59	-0.01
9.	IC- 334838	1.16	-2.95	-0.02	60.	IC- 335048	1.41	7.78*	-0.01
10.	IC- 334841	1.28	1.47	-0.01	61.	IC- 335050	1.30	-8.02*	-0.01
11.	IC- 334842	1.35	-1.24	-0.01	62.	IC- 335051	1.30	7.44*	0.03
12.	IC- 334846	1.19	3.87	0.00	63.	IC- 335053	1.41	7.88*	-0.02
13.	IC- 334848	1.20	-2.77	-0.01	64.	IC- 335056	1.20	5.67*	-0.01
14.	IC- 334853	1.27	-2.87	-0.02	65.	IC- 335060	1.26	1.43	0.04
15.	IC- 334855	1.08	1.79	-0.02	66.	IC- 335062	1.22	-0.92	-0.01
16.	IC- 334863	1.18	1.06	-0.02	67.	IC- 335068	1.18	-1.10	0.06
17	IC- 334864	1.10	-2.99	0.18*	68.	IC- 335069	1.13	1.33	0.00
18.	IC- 334867	1.13	3.48	-0.02	69.	IC- 335079	1.17	6.98*	-0.02
19.	IC- 334869	1.39	1.91	0.02	70.	IC- 335082	1.26	2.64	0.13
20.	IC- 334871	1.14	-0.87	-0.01	71.	IC- 335086	1.21	2.85	0.00
21.	IC- 334872	1.17	2.64	0.00	72.	IC- 335089	1.19	7.39*	0.00
22.	IC- 334876	1.22	-3.56*	0.00	73.	IC- 335092	1.30	-1.54	0.00
23.	IC- 334877	1.23	-4.31*	0.10	74.	IC- 335094	1.27	1.25	0.00
24.	IC- 334879	1.12	-3.37*	-0.01	75.	IC- 335098	1.26	5.39*	0.01
25.	IC- 334880	1.08	10.42*	-0.02	76.	IC- 335103	1.31	0.12	0.01
26.	IC- 334881	1.16	0.59	0.01	77.	IC- 335109	1.26	-1.73	0.00
27.	IC- 334884	1.12	-1.18	0.07	78.	IC- 335110	1.26	-5.24*	0.00
28.	IC- 334889	1.06	3.58	-0.02	79.	IC- 335111	1.23	6.90*	-0.01
29.	IC- 334904	1.06	-4.83*	0.01	80.	IC- 335112	1.29	6.55*	-0.01
30.	IC- 334915	1.30	6.08*	-0.02	81.	IC- 335115	1.04	3.86	-0.01
31.	IC- 334920	1.11	4.33	0.02	82.	IC- 335116	1.49	7.06*	-0.02
32.	IC- 334929	1.18	0.21	-0.01	83.	IC- 335117	1.27	-1.58	-0.01
33.	IC- 334932	1.31	2.53	0.01	84.	IC- 335120	1.27	3.92	0.03
34.	IC- 334942	1.20	3.99	0.13	85.	IC- 335122	1.30	1.45	0.00
35.	IC- 334943	1.09	-3.37*	-0.01	86.	IC- 335128	1.27	-10.56*	0.02
36.	IC- 334944	1.21	-1.91	0.02	87.	IC- 335131	1.43	-2.42	0.00
37.	IC- 334945	1.13	-0.03	-0.01	88.	IC- 335138	1.14	-4.10*	0.01
38.	IC- 334947	0.98	3.85	0.03	89.	IC- 335141	1.30	6.44*	0.00
39.	IC- 334949	1.18	-0.63	0.00	90.	IC- 335144	1.36	-3.83*	-0.01
40.	IC- 334954	1.11	1.47	-0.01	91.	IC- 335148	1.29	2.33	0.00
41.	IC- 334955	1.29	-6.20*	0.03	92.	IC- 335149	1.23	0.71	-0.02
42.	IC- 334957	1.19	0.30	0.03	93.	IC- 335152	1.39	-3.15	0.05
43.	IC- 334973	1.28	-0.34	0.20*	94.	IC- 335156	1.40	-5.06*	-0.01
44.	IC- 334974	1.47	8.66*	0.04	95.	IC- 335158	1.20	6.21*	-0.01
45.	IC- 334989	1.27	0.61	0.07	96.	IC- 335164	1.26	3.07	0.01
46.	IC- 334996	1.59	1.59	-0.01	97.	IC- 335169	1.24	1.27	0.01
47.	IC- 334999	1.30	-8.54-	-0.01	98.	IC- 335173	1.24	-1.91	0.02
48.	IC- 335000	1.31	-1.94	-0.02	99.	IC- 335178	1.20	8.02*	-0.01
49.	IC- 335009	1.35	2.30	-0.01	100.	IC- 335184	1.30	0.61	-0.02
50.	IC- 335017	1.39	1.13	-0.01	101.	African Tall	1.62	0.24	0.00
51.	IC- 335024	1.53	1.46	0.03					

Table 4.42 Estimation of stability parameters for kernel length.

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	0.84	3.95*	0.04**	52.	IC- 335025	0.83	1.05	0.00
2.	IC- 334825	0.95	-0.37	0.00	53.	IC- 335027	0.90	1.97	0.02
3.	IC- 334826	0.82	4.07*	0.00	54.	IC- 335028	0.86	-1.79*	0.01
4.	IC- 334830	0.80	1.95	0.00	55.	IC- 335032	0.91	3.31*	0.00
5.	IC- 334833	0.86	0.73	0.01	56.	IC- 335035	0.90	-0.01	0.00
6.	IC- 334834	0.82	4.49*	0.02	57.	IC- 335041	0.92	0.27	0.03
7.	IC- 334836	0.88	0.56	0.01	58.	IC- 335043	0.91	2.64	0.01
8.	IC- 334837	0.83	2.98*	0.00	59.	IC- 335045	0.88	-1.83*	0.00
9.	IC- 334838	0.92	-0.63	0.00	60.	IC- 335048	0.83	-0.13	0.01
10.	IC- 334841	0.94	-1.20*	0.00	61.	IC- 335050	0.84	-1.00*	0.00
11.	IC- 334842	0.95	2.18	0.00	62.	IC- 335051	0.85	2.48	0.00
12.	IC- 334846	0.96	1.17	0.00	63.	IC- 335053	0.81	0.18	0.00
13.	IC- 334848	0.91	2.97*	0.00	64.	IC- 335056	0.75	1.97	0.00
14.	IC- 334853	1.00	0.91	0.00	65.	IC- 335060	0.79	0.76	0.00
15.	IC- 334855	0.88	3.09*	0.00	66.	IC- 335062	0.75	-1.23*	0.00
16.	IC- 334863	0.93	-2.55*	0.00	67.	IC- 335068	0.87	-0.68	0.00
17	IC- 334864	0.89	-0.19	0.00	68.	IC- 335069	0.82	-1.59*	0.00
18.	IC- 334867	0.90	-1.65*	0.00	69.	IC- 335079	0.82	0.89	0.00
19.	IC- 334869	0.96	2.57	0.00	70.	IC- 335082	0.78	0.89	0.00
20.	IC- 334871	0.87	3.07*	0.00	71.	IC- 335086	0.75	4.23*	0.00
21.	IC- 334872	0.85	0.57	0.00	72.	IC- 335089	0.83	0.69	0.00
22.	IC- 334876	0.90	1.83	0.00	73.	IC- 335092	0.83	1.51	0.00
23.	IC- 334877	0.90	1.00	0.01	74.	IC- 335094	0.85	-0.35	0.00
24.	IC- 334879	0.90	-1.45*	0.00	75.	IC- 335098	0.82	3.44*	0.00
25.	IC- 334880	0.86	2.13	0.00	76.	IC- 335103	0.82	0.09	0.00
26.	IC- 334881	0.87	0.35	0.01	77.	IC- 335109	0.81	1.94	0.00
27.	IC- 334884	0.90	-2.57*	0.00	78.	IC- 335110	0.82	-1.84*	0.00
28.	IC- 334889	0.82	1.29	0.00	79.	IC- 335111	0.84	3.35*	0.01
29.	IC- 334904	0.81	2.91*	0.01	80.	IC- 335112	0.82	2.70	0.00
30.	IC- 334915	0.86	3.07*	0.00	81.	IC- 335115	0.82	-1.04*	0.00
31.	IC- 334920	0.84	-2.18*	0.00	82.	IC- 335116	0.89	1.26	0.01
32.	IC- 334929	0.94	-0.38	0.00	83.	IC- 335117	0.85	-0.83	0.01
33.	IC- 334932	1.00	1.33	0.00	84.	IC- 335120	0.85	2.29	0.00
34.	IC- 334942	0.94	-0.66	0.00	85.	IC- 335122	0.87	-0.18	0.01
35.	IC- 334943	0.98	0.44	0.00	86.	IC- 335128	0.80	2.35	0.00
36.	IC- 334944	0.92	2.08	0.00	87.	IC- 335131	0.80	1.82	0.00
37.	IC- 334945	0.90	0.07	0.01	88.	IC- 335138	0.86	1.16	0.00
38.	IC- 334947	0.85	1.96	0.00	89.	IC- 335141	0.83	0.35	0.00
39.	IC- 334949	0.86	3.34*	0.00	90.	IC- 335144	0.89	2.98*	0.00
40.	IC- 334954	1.02	0.09	0.00	91.	IC- 335148	0.89	1.51	0.00
41.	IC- 334955	0.89	-0.78	0.08**	92.	IC- 335149	0.82	2.68	0.00
42.	IC- 334957	0.88	0.94	0.01	93.	IC- 335152	0.93	-0.53	0.00
43.	IC- 334973	0.87	1.93	0.00	94.	IC- 335156	0.76	1.73	0.00
44.	IC- 334974	0.93	3.31*	0.03	95.	IC- 335158	0.82	1.15	0.01
45.	IC- 334989	0.77	1.00	0.06**	96.	IC- 335164	0.82	0.33	0.00
46.	IC- 334996	0.84	-0.73	0.01	97.	IC- 335169	0.88	1.45	0.00
47.	IC- 334999	0.92	0.89	0.00	98.	IC- 335173	0.90	-0.06	0.00
48.	IC- 335000	0.86	2.23	0.00	99.	IC- 335178	0.81	3.77*	0.01
49.	IC- 335009	0.88	0.29	0.01	100.	IC- 335184	0.80	-0.68	0.00
50.	IC- 335017	0.95	2.82	0.00	101.	African Tall	0.94	0.04	0.00
51.	IC- 335024	0.89	0.29	0.01					

Table 4.43 Estimation of stability parameters for kernel width.

S. No.	Acc. No.	Mean	bi	S ^{2}di	S. No	Acc. No.	Mean	bi	S ^{2}di
1.	IC- 334821	0.81	6.00	0.02	52.	IC- 335025	0.79	5.90	0.00
2.	IC- 334825	0.83	0.58	0.00	53.	IC- 335027	0.86	3.54	0.00
3.	IC- 334826	0.78	2.98	0.00	54.	IC- 335028	0.78	-0.89	0.00
4.	IC- 334830	0.83	10.73*	0.01	55.	IC- 335032	0.86	0.05	0.00
5.	IC- 334833	0.83	-2.30	0.01	56.	IC- 335035	0.79	-0.52	0.00
6.	IC- 334834	0.75	23.33*	0.02	57.	IC- 335041	0.84	0.73	0.01
7.	IC- 334836	0.91	0.24	0.00	58.	IC- 335043	0.87	-3.32	0.02
8.	IC- 334837	0.85	9.05	0.01	59.	IC- 335045	0.89	-9.34*	0.00
9.	IC- 334838	0.93	-0.03	0.00	60.	IC- 335048	0.86	2.35	0.00
10.	IC- 334841	0.86	-3.12	0.00	61.	IC- 335050	0.85	-3.01	0.01
11.	IC- 334842	0.83	4.69	0.00	62.	IC- 335051	0.87	6.23	0.00
12.	IC- 334846	0.95	9.50*	0.00	63.	IC- 335053	0.79	-3.64	0.00
13.	IC- 334848	0.80	13.22*	0.01	64.	IC- 335056	0.79	11.58*	0.00
14.	IC- 334853	0.92	2.74	0.00	65.	IC- 335060	0.74	-6.14	0.00
15.	IC- 334855	0.84	11.58*	0.00	66.	IC- 335062	0.75	-6.19	0.00
16.	IC- 334863	0.86	-2.53	0.01	67.	IC- 335068	0.81	-2.15	0.00
17	IC- 334864	0.85	6.26	0.01	68.	IC- 335069	0.81	6.39	0.00
18.	IC- 334867	0.91	6.97	0.00	69.	IC- 335079	0.79	10.30*	0.00
19.	IC- 334869	0.99	4.34	0.00	70.	IC- 335082	0.86	6.74	0.01
20.	IC- 334871	0.87	9.80*	0.02	71.	IC- 335086	0.74	11.38*	0.00
21.	IC- 334872	0.75	-6.83	0.00	72.	IC- 335089	0.83	9.76*	0.00
22.	IC- 334876	0.86	-3.15	0.00	73.	IC- 335092	0.91	14.76*	0.01
23.	IC- 334877	0.89	0.39	0.03*	74.	IC- 335094	0.90	-2.98	0.00
24.	IC- 334879	0.83	-3.55	0.00	75.	IC- 335098	0.84	13.65*	0.00
25.	IC- 334880	0.88	9.69*	0.00	76.	IC- 335103	0.87	5.91	0.00
26.	IC- 334881	0.87	-9.90*	0.00	77.	IC- 335109	0.81	1.75	0.00
27.	IC- 334884	0.87	-14.82*	0.00	78.	IC- 335110	0.78	-17.05*	0.00
28.	IC- 334889	0.82	4.01	0.00	79.	IC- 335111	0.79	7.44	0.00
29.	IC- 334904	0.82	2.43	0.00	80.	IC- 335112	0.84	5.20	0.00
30.	IC- 334915	0.83	5.95	0.01	81.	IC- 335115	0.75	-6.01	0.00
31.	IC- 334920	0.79	-2.73	0.00	82.	IC- 335116	0.83	-5.28	0.00
32.	IC- 334929	0.83	-8.36*	0.00	83.	IC- 335117	0.83	-8.62*	0.00
33.	IC- 334932	0.94	7.35	0.00	84.	IC- 335120	0.85	-0.21	0.01
34.	IC- 334942	0.81	-10.16*	0.02	85.	IC- 335122	0.84	-12.42*	0.00
35.	IC- 334943	0.90	4.01	0.01	86.	IC- 335128	0.84	-7.22	0.00
36.	IC- 334944	0.80	-1.58	0.00	87.	IC- 335131	0.84	4.01	0.00
37.	IC- 334945	0.76	-6.14	0.00	88.	IC- 335138	0.79	-3.69	0.01
38.	IC- 334947	0.78	8.94	0.00	89.	IC- 335141	0.84	3.03	0.00
39.	IC- 334949	0.79	12.25*	0.00	90.	IC- 335144	0.78	-4.08	0.01
40.	IC- 334954	0.93	-11.99*	0.00	91.	IC- 335148	0.92	5.58	0.00
41.	IC- 334955	0.82	-12.19*	0.03*	92.	IC- 335149	0.79	-4.63	0.00
42.	IC- 334957	0.86	8.22	0.00	93.	IC- 335152	0.86	-11.63*	0.00
43.	IC- 334973	0.81	7.08	0.00	94.	IC- 335156	0.75	12.30*	0.02
44.	IC- 334974	0.87	-1.73	0.01	95.	IC- 335158	0.74	0.87	0.01
45.	IC- 334989	0.75	3.77	0.03*	96.	IC- 335164	0.80	0.21	0.00
46.	IC- 334996	0.86	-8.74*	0.00	97.	IC- 335169	0.80	-0.19	0.01
47.	IC- 334999	0.85	-9.71*	0.00	98.	IC- 335173	0.85	-7.00	0.00
48.	IC- 335000	0.83	8.51	0.00	99.	IC- 335178	0.81	12.02*	0.00
49.	IC- 335009	0.84	-5.95	0.00	100.	IC- 335184	0.81	-6.46	0.00
50.	IC- 335017	0.85	7.48	0.00	101.	African Tall	0.90	0.58	0.00
51.	IC- 335024	0.88	-15.06*	0.00					

Table 4.44 Estimation of stability parameters for test weight.

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	20.19	2.30	25.82**	52.	IC- 335025	21.27	-0.58*	7.95
2.	IC- 334825	19.89	0.82	58.33**	53.	IC- 335027	19.13	0.73	0.43
3.	IC- 334826	18.30	-0.62*	-0.97	54.	IC- 335028	18.30	0.20	9.70
4.	IC- 334830	20.79	1.46	16.64*	55.	IC- 335032	20.92	2.04	1.91
5.	IC- 334833	20.07	0.70	-0.19	56.	IC- 335035	20.55	2.07	13.16*
6.	IC- 334834	16.85	2.14	82.83**	57.	IC- 335041	21.06	-0.28	7.53
7.	IC- 334836	20.17	0.24	-0.84	58.	IC- 335043	19.61	0.28	1.52
8.	IC- 334837	18.86	1.48	0.73	59.	IC- 335045	18.53	0.25	-0.31
9.	IC- 334838	22.47	2.13	1.93	60.	IC- 335048	20.59	0.39	-0.29
10.	IC- 334841	23.20	1.04	-0.45	61.	IC- 335050	18.79	-0.85*	17.20*
11.	IC- 334842	21.54	0.70	-0.98	62.	IC- 335051	20.53	0.12	14.68*
12.	IC- 334846	21.15	1.00	-0.95	63.	IC- 335053	19.19	0.16	1.27
13.	IC- 334848	20.83	0.22	-0.98	64.	IC- 335056	18.43	1.77	-0.80
14.	IC- 334853	25.56	-0.91*	-0.97	65.	IC- 335060	16.77	0.31	23.83**
15.	IC- 334855	22.23	1.59	26.62**	66.	IC- 335062	15.71	0.67	13.64*
16.	IC- 334863	23.10	0.93	0.96	67.	IC- 335068	17.41	-0.42*	-0.98
17	IC- 334864	21.05	-1.85*	10.00	68.	IC- 335069	15.97	1.10	14.62*
18.	IC- 334867	22.15	1.56	2.87	69.	IC- 335079	17.02	2.34*	-0.81
19.	IC- 334869	24.72	2.48*	1.36	70.	IC- 335082	17.74	2.73*	5.60
20.	IC- 334871	23.48	1.41	4.28	71.	IC- 335086	14.53	1.47	13.64*
21.	IC- 334872	21.12	2.32	43.36**	72.	IC- 335089	18.07	2.32	-0.97
22.	IC- 334876	22.20	-0.02	0.94	73.	IC- 335092	21.46	0.29	9.74
23.	IC- 334877	21.91	2.38*	-0.97	74.	IC- 335094	21.47	0.41	4.01
24.	IC- 334879	19.45	1.23	0.16	75.	IC- 335098	18.00	2.26	8.53
25.	IC- 334880	19.50	3.07*	0.67	76.	IC- 335103	18.83	2.75*	10.01
26.	IC- 334881	20.34	1.53	-0.96	77.	IC- 335109	18.81	-0.62	46.43**
27.	IC- 334884	22.69	0.21	1.26	78.	IC- 335110	16.35	0.36	5.65
28.	IC- 334889	20.27	1.06	6.40	79.	IC- 335111	16.73	0.89	15.93*
29.	IC- 334904	19.83	-0.39*	7.78	80.	IC- 335112	18.85	3.19*	-0.56
30.	IC- 334915	21.14	0.59	25.65**	81.	IC- 335115	15.54	0.33	17.10*
31.	IC- 334920	19.44	1.05	-0.91	82.	IC- 335116	22.39	0.21	7.96
32.	IC- 334929	22.19	2.90*	10.45*	83.	IC- 335117	19.86	0.92	11.77*
33.	IC- 334932	24.58	2.29	3.85	84.	IC- 335120	18.31	1.97	-0.71
34.	IC- 334942	22.49	1.79	138.32**	85.	IC- 335122	19.87	-0.44*	12.60*
35.	IC- 334943	21.80	2.88*	-0.97	86.	IC- 335128	17.75	0.47	1.15
36.	IC- 334944	19.92	2.99*	25.50**	87.	IC- 335131	20.12	-0.06	14.77*
37.	IC- 334945	19.21	0.35	54.54**	88.	IC- 335138	17.78	0.46	0.24
38.	IC- 334947	18.85	2.48*	12.11*	89.	IC- 335141	18.22	2.45*	3.42
39.	IC- 334949	20.24	1.53	9.38	90.	IC- 335144	18.03	-1.03*	-0.86
40.	IC- 334954	24.44	0.69	27.17**	91.	IC- 335148	20.85	0.87	22.43**
41.	IC- 334955	20.63	1.61	48.99**	92.	IC- 335149	17.19	1.42	-0.75
42.	IC- 334957	21.82	0.08	-0.94	93.	IC- 335152	18.18	-0.89*	2.04
43.	IC- 334973	20.36	2.09	16.30*	94.	IC- 335156	18.20	-0.37*	20.47**
44.	IC- 334974	20.80	0.19	13.79*	95.	IC- 335158	16.11	2.36*	12.36*
45.	IC- 334989	17.73	2.33*	58.10**	96.	IC- 335164	18.68	1.24	-0.19
46.	IC- 334996	21.25	1.89	0.40	97.	IC- 335169	18.21	1.44	0.40
47.	IC- 334999	19.92	0.19	-0.60	98.	IC- 335173	17.45	0.50	0.01
48.	IC- 335000	20.79	0.35	0.86	99.	IC- 335178	17.76	1.88	38.50**
49.	IC- 335009	21.37	1.97	42.91**	100.	IC- 335184	18.14	-0.15	25.75**
50.	IC- 335017	20.72	0.92	4.81	101.	African Tall	25.73	0.15	0.31
51.	IC- 335024	24.57	-0.43*	0.32					

Table 4.45 **Estimation of stability parameters for seed yield/ plant.**

S. No.	Acc. No.	Mean	bi	S^2di	S. No	Acc. No.	Mean	bi	S^2di
1.	IC- 334821	175.94	10.11*	538.46	52.	IC- 335025	172.90	3.72	529.88
2.	IC- 334825	212.53	0.97	149.50	53.	IC- 335027	218.05	2.93	6024.41**
3.	IC- 334826	174.14	2.50	-145.02	54.	IC- 335028	194.72	-6.14*	24.44
4.	IC- 334830	157.22	7.92*	773.85	55.	IC- 335032	214.19	4.39	3076.29**
5.	IC- 334833	156.30	0.33	36.19	56.	IC- 335035	198.52	9.86*	1388.45
6.	IC- 334834	158.95	2.30	703.93	57.	IC- 335041	210.22	-11.03*	4263.59**
7.	IC- 334836	220.85	23.93*	5324.48**	58.	IC- 335043	213.30	11.22*	1523.90
8.	IC- 334837	162.86	1.30	1436.62	59.	IC- 335045	149.04	-5.53*	1267.32
9.	IC- 334838	215.12	11.18*	2083.28*	60.	IC- 335048	211.37	-10.15*	134.54
10.	IC- 334841	172.68	-5.30*	684.39	61.	IC- 335050	180.24	-9.21*	321.61
11.	IC- 334842	168.70	4.38	1044.96	62.	IC- 335051	184.59	-2.38	3212.59**
12.	IC- 334846	165.46	6.05	106.15	63.	IC- 335053	190.27	-0.01	217.80
13.	IC- 334848	214.72	6.49	136.12	64.	IC- 335056	168.05	5.21	4653.41**
14.	IC- 334853	235.78	-9.56*	2308.75*	65.	IC- 335060	151.78	-1.23	407.44
15.	IC- 334855	167.75	-4.07	1297.13	66.	IC- 335062	152.03	1.94	39.44
16.	IC- 334863	161.53	-4.48	1503.09	67.	IC- 335068	178.57	-0.25	3180.92**
17	IC- 334864	211.11	-4.97*	1400.39	68.	IC- 335069	172.03	-1.24	183.98
18.	IC- 334867	170.46	-3.60	-140.41	69.	IC- 335079	163.14	7.37*	765.27
19.	IC- 334869	208.91	3.24	-42.43	70.	IC- 335082	212.61	7.74*	3245.34**
20.	IC- 334871	190.97	-7.08*	1706.75*	71.	IC- 335086	155.37	0.28	772.39
21.	IC- 334872	131.44	2.26	1916.01*	72.	IC- 335089	168.51	3.09	128.61
22.	IC- 334876	182.56	-10.13*	100.37	73.	IC- 335092	190.04	0.55	-91.72
23.	IC- 334877	224.51	-10.68*	-146.10	74.	IC- 335094	245.48	-4.71*	681.11
24.	IC- 334879	150.50	6.94*	-131.34	75.	IC- 335098	182.32	1.10	1152.87
25.	IC- 334880	135.22	3.57	1571.78*	76.	IC- 335103	185.96	2.87	518.76
26.	IC- 334881	165.34	-1.26	-122.16	77.	IC- 335109	171.96	-3.58	143.28
27.	IC- 334884	142.96	-4.39	1005.00	78.	IC- 335110	179.96	-3.40	-3.18
28.	IC- 334889	151.14	4.42	643.73	79.	IC- 335111	175.04	0.70	195.76
29.	IC- 334904	126.21	5.61	115.63	80.	IC- 335112	207.51	6.34*	1883.38*
30.	IC- 334915	168.53	-4.08	295.50	81.	IC- 335115	154.47	5.16	3870.70**
31.	IC- 334920	147.53	5.48	-119.90	82.	IC- 335116	248.51	-0.04	2125.13*
32.	IC- 334929	197.84	-0.35	-81.40	83.	IC- 335117	214.42	7.65*	783.25
33.	IC- 334932	208.97	15.76*	980.93	84.	IC- 335120	213.17	-0.89	5039.76**
34.	IC- 334942	130.20	6.88*	-134.32	85.	IC- 335122	238.27	-10.25*	449.72
35.	IC- 334943	143.72	5.86	337.96	86.	IC- 335128	174.97	-2.01	3300.36**
36.	IC- 334944	182.77	9.82*	43.48	87.	IC- 335131	173.56	-3.04	622.74
37.	IC- 334945	167.47	5.76	490.15	88.	IC- 335138	179.55	-1.23	2994.56**
38.	IC- 334947	175.11	5.06	-95.20	89.	IC- 335141	137.85	9.50*	1328.32
39.	IC- 334949	154.67	-5.12*	365.31	90.	IC- 335144	157.19	0.84	1137.04
40.	IC- 334954	172.03	0.85	207.91	91.	IC- 335148	226.82	-6.12*	2510.01*
41.	IC- 334955	162.17	6.72*	1780.30*	92.	IC- 335149	169.70	4.22	545.07
42.	IC- 334957	196.00	-12.79*	211.83	93.	IC- 335152	193.22	-5.38*	2696.55*
43.	IC- 334973	174.57	-0.76	7372.45**	94.	IC- 335156	223.15	-6.76*	703.94
44.	IC- 334974	245.44	-15.66*	3471.14**	95.	IC- 335158	191.27	1.36	7309.72**
45.	IC- 334989	159.23	9.65*	-130.80	96.	IC- 335164	167.49	5.20	118.15
46.	IC- 334996	167.00	0.62	-119.39	97.	IC- 335169	182.87	-0.04	-92.79
47.	IC- 334999	237.66	11.80*	131.20	98.	IC- 335173	201.72	-1.79	-128.57
48.	IC- 335000	210.93	-8.75*	-94.99	99.	IC- 335178	167.56	2.53	1118.56
49.	IC- 335009	213.94	13.66*	6770.03**	100.	IC- 335184	176.89	-3.58	6.40
50.	IC- 335017	194.97	6.70*	-98.90	101.	African Tall	261.61	-2.29	-143.53
51.	IC- 335024	260.64	2.45	3411.73**					

Chapter - V
Discussion

DISCUSSION

Maize, a nutritious cereal is used for human consumption besides feed and fodder. In spite of many beneficial uses, it has not so far received adequate attention from the point of view of fodder genetic improvement and management. The crosses involving diverse parents are expected to generate considerable amount of genetic variability, in order to select diverse parents from existing genetic stock stratification of diversity is important (Bhatt, 1970). The nature and magnitude of various genetic parameters, character association and G x E interaction under changing environments serves as complementary information.

Salient features of the results obtained in this study are discussed in the light of the above considerations under the following heads:

5.1 Genetic variability

5.2 Genetic divergence

5.3 Correlation and path-coefficient analysis

5.4 Stability analysis

5.1 Genetic Variability

Knowledge of extent of genetic variation for various characters as well as the magnitude of heritable and non-heritable components of variation is necessary to initiate an efficient breeding programme. Further, the understanding of the possible changes in estimates of different genetic parameters and the expected genetic gain from selection is also important for the breeders with a view to formulate a sound selection criteria.

The studies in present investigation revealed considerable genetic variation for different fodder and seed yield traits in different environments as well as over the environments. Qualitative traits showed eighty five

accessions had dark green leaf blade while 16 accessions showed light green leaf blade. Among sheath colour variability, 69 accessions had dark green sheath and 32 were having light green sheath. There was no colour variation in midrib colour as all accessions possessed white midrib. Thirty four accessions had dark green stem colour while 67 showed light green stem. There was wide variation in kernel colour. Twenty two accessions had dark yellow kernels, 49 light yellow, 14 white, 8 variegated, 1 brown and 7 accessions had yellow kernels. There was also substantial variation among the Kernel row arrangement in the Cobs of maize accessions. Fifty three accessions showed regular arrangement, 27 straight, 15 irregular and only six accessions showed spiral row arrangement. Eighty three accessions had shrunken kernels, 15 round, 7 indented while only one accession showed pointed kernels. Seventeen accessions showed small kernel size, 53 medium and 31 accessions showed bold kernels. Fifty three accessions had cylindrical cob shape while 48 showed conical shape. These findings are in consonance with Katiyar et al. (2001).

Perusal of the results indicated the existence of significant difference in yield and quality traits of the fodder as well as seed along with their component characters in all the environments (Table 4.2 to 4.5). Estimates of the different quantitative parameters for the fodder and seed yield and their component characters over environments showed that amongst fodder, green fodder yield itself was highly variable. Similarly the seed yield/plant also exhibited maximum variation amongst the accessions followed by its contributing traits like number of kernels/row, thereby, indicating the accessions under study were relatively more variable for these characters and provide an opportunity for selection. On the other hand crude protein content in leaf -stem and cob width for seed yield showed low variation over the environments.

Considering mean performance of the accessions (Table 5.1) the accession IC-335056 and IC-334973 were observed to be earliest for days to 50% silking as they flowered in 43 and 48 days respectively, whereas, the genotype African Tall and IC-334833 were considered late in this trait as they flowered in 59 and 54 days respectively. For plant height African Tall and IC-334855 were found to be taller as compared to others. The accessions

identified, as dwarf in plant height are IC-335060 and IC-335056. The genotype producing maximum number of leaves is African Tall and IC-335035. Maximum green fodder yield was observed in genotypes like African

Table 5.1 Accessions showing superior performance for various fodder characters in maize

Sr. No.	Characters	Name of the accessions	
1	Days to 50% silking	Early	IC- (335056, 334973, 334999, 335000, 335068, 335086, 334915, 335062, 335111, 335184)
		Late	African tall, CI- (334833, 334853, 334863, 334836, 334945, 334834, 334838, 334942, 334943
2	Plant height (cm)	Dwarf	IC- (335060, 335056, 335086, 335069, 335062, 335068, 335079, 335082, 335116, 334821)
		Tall	African tall, IC- (334855, 334830, 334846, 334834, 334833, 335035, 334942, 334838, 335032)
3	No. of leaves/ plant	African tall, IC- (335035, 334943, 334864, 334842, 335041, 334876, 334855, 334942, 334841)	
4	Leaf blade length (cm)	African tall, IC- (334999, 334855, 334837, 334833, 334872, 334846, 335053, 335009, 335043)	
5	Sheath length (cm)	African tall, IC- (334833, 334846, 334879, 334855, 334830, 334872, 335035, 335089, 335148)	
6	Leaf width (cm)	IC- 334932, African tall, IC- (334846, 334838, 334841, 334842, 334837, 334833, 334834, 335128)	
7	Stem girth (cm)	African tall, IC- (334848, 334833, 334834, 334846, 334945, 334838, 334842, 334830, 335041)	
8	Green fodder yield/ plant (g)	African tall, IC- (334846, 335053, 334833, 334855, 334872, 335017, 334943, 334830, 334841)	
9	Dry fodder yield/ plant (g)	African tall, IC- (334833, 334846, 334834, 334855, 334942, 334830, 335000, 335053, 334842)	
10	Leaf - Stem ratio	IC- (335068, 334889, 335031, 335110, 335144, 335079, 334836, 335035, 335069, 335120)	
11	Crude protein (%)	IC- (334841, 334920, 335148, 334904, 334889, 335103, 334880, 335051, 335060, 334848)	

Tall and IC-334846 whereas maximum dry fodder yield was recorded for African tall and IC-334833.

In present investigation the germplasm lines of maize were evaluated for yield and other forage traits in the fodder types. The study revealed that all the lines possessed less green fodder yield as compared to African Tall. As

regard dry fodder yield, African Tall recorded quite high dry fodder yield/plant compared to germplasm lines. It was observed that genotypes with high dry fodder yield were also late in flowering. Malaviya *et al.* (2002) reported similar results. Gupta *et al.* (1984) have recommended that fodder variety should be early growth type and late flowering type as late flowering types have been observed to be are better in fodder production. Bunting (1973) has indicated that there are genotypic differences in rate and duration of dry matter accumulation in maize, which also depends on the canopy structure and barrenness. He emphasized that for selecting suitable canopy, selection should be made for larger leaf size and shape.

Being a cereal crop, maize is not rich in protein content. However, some accessions like IC-334841 and IC-334920 were identified to be very promising as they contain about 11-12.24% crude protein in leaf and stem parts whereas African Tall had very low crude protein content (%) amongst all accessions. These results supported by the earlier findings of Singh and Katiyar (1999) and Samanta *et al.* (2003).

Among the seed yield traits (Table 5.2), the germplasm lines like IC- 335111 and IC-335069 were found as early maturing type. Whereas, African Tall and IC-334904 were found late in maturity. Maximum Cob length was recorded for African Tall and IC-335024. Maximum Cob width was reported for IC-334932 and IC-334877. IC-334942 and IC-334947 were rich in number of kernel rows and Maximum kernels/ row was observed in IC-335094 and IC-335120. The germplasm lines with big shank size were African Tall and IC-334996. Accessions like IC-334954 and IC-334853 had big kernel length and IC-334869 and IC-334846 were found large in kernel width. Maximum test weight was recorded for African Tall and IC-334853. African Tall also showed maximum seed yield/plant followed by IC-335024. These results are in conformity with those of Gouesnard *et al.* (1989), Turgut *et al.* (1995), Chen Ling *et al.* (1996) and Katiyar *et al.* (2001).

The phenotypic coefficient of variation helps in the measurement of the range of phenotypic diversity in various characters and provides a mean to compare phenotypic variability in quantitative characters. Genotypic coefficient of variation gives a picture of the extent of genetic variability in the population. High genotypic coefficient of variation was observed for green

fodder yield/plant whereas it was moderate for dry fodder yield/plant. Similarly, among seed yield traits genotypic coefficient of variation was high for number of kernels/row and moderate for seed yield/plant. There was a close relationship between phenotypic and genotypic coefficient of variation in almost all the characters. However, phenotypic coefficient of variation was slightly higher than their corresponding genotypic coefficient of variation.

Table 5.2 Accessions showing superior performance for various seed characters in maize

Sr. No.	Characters	Name of the accessions	
1	Days to maturation	Early	IC- (335098, 334974, 335060, 335062, 335086, 335068, 334973, 335056, 335069 and 335111)
		Late	IC- (334864, 334867, 334853, 334954, 334834, 334942, 334943, 334945, 334904) and African tall.
2	Ear length	African tall, IC- (335024, 335996, 335110, 335117, 335045, 335009, 335050, 335158, 334999)	
3	Ear width	IC- (334932, 334877, 335032, 335024, 334999, 334944, 335009, 334842) and African tall.	
4	Number of kernel rows	IC- (334942, 334947, 334942, 335158, 334848, 335060, 335079, 335068, 335050and 335041)	
5	Number of kernels/ row	IC- (335094, 335120, 335158, African tall, 335117, 335035, 335109, 335173, 335027, 335111)	
6	Shank diameter	African tall, IC- (334996, 335024, 335116, 335025, 334974, 335043, 335131, 335045, 335048)	
7	Kernel length	IC- (334954, 334853, 334932, 334943, 334846, 334869, 334825, 334842, 335017, 334841)	
8	Kernel width	IC- (334869, 334846, 334932, 334838, 334954, 334853, 335148, 334836, 335092, 334867)	
9	100-seed weight	African tall, IC- (334853, 334869, 334932, 335024, 334954, 334871, 334841, 334863 and 334884)	
10	Seed yield/ plant	African tall, IC- (335024, 335116, 335094, 33334974, 335022, 334999, 334853, 335148 and 334877)	

Swarup and Chaugale (1962) suggested that genotypic coefficient of variation alone is not sufficient for determination of the amount of heritable variation and hence heritability in conjunction with genetic advance is required to be studied. Panse (1957) expressed that high heritability together with high genetic advance was indicative of additive gene effects, and high heritability

associated with low genetic advance was indication of dominance and epistatic effects.

In present investigation, high heritability coupled with high genetic advance was observed for green fodder yield/plant, days to maturity and days to 50% silking, indicating that these traits could be improved by simple selection. These results are in conformity with those of Gallais *et al.* (1983), El- Harary (1989), Singh *et al.* (1989), Arha *et al.* (1990),Pischedd and Magaga (1990), Alika (1994), Satyanarayana and Saikumar (1995), Betran and Hallouer (1996), Chen Ling *et al.*(1996),Mani and Bisht (1996), and Tusuz and Balabanli (1997).

5.2 Genetic Divergence

Genetic improvement mainly depends upon the amount of genetic variability present in a population. In any crop, germplasm serves as a valuable source of base population and provides scope for selection. Information on the nature and degree of genetic divergence would help the plant breeder in choosing the right type of parents for breeding programme (Vivekanandan and Subramanian, 1993).

Classification of genetic diversity in the germplasm has special significance because of two reasons. First, it is difficult to evaluate large number of lines in breeding programmes obviously due to practical limitations and second because many of the accessions may be genetically more or less similar due to common ancestor. Various approaches like geographical diversity (Dhawan and Singh, 1961; Moll et. al., 1962), Coefficient of racial likeness (Pearson, 1926), discriminate fruition (Fisher, 1936), metro glyph and index score analysis (Anderson, 1957) have been suggested for classification and selection considering many variables simultaneously. But these failed to provide foolproof measure of genetic diversity and its quantification assessment.

The spectrum of variability in maize for fodder and seed yield and other traits depends on the genetic diversity of combining parents. Hence, estimation of genetic diversity for yield and other traits among accessions is important for planning the future crossing programmes. Characterization of

genetic divergence for selection of suitable and diverse genotypes should be based on sound statistical procedures, such as D^2 statistic (Mahalanobis, 1936) and non-hierarchical Euclidean cluster analysis (Beale (1969) and Spark (1973). Non-hierarchical Euclidean cluster analysis is the technique to measure the extent of similarity/ dissimilarity among the accessions for the observed metric traits. This technique was used to work out the extent of variation/ similarity among one hundred and one accessions of maize based on fodder yield, seed yield and quality characters.

In the present study, the analysis of variance revealed significant difference among the maize accessions for all the traits studied. Based on non-hierarchical Euclidean cluster analysis, one hundred and one genetic lines were grouped into eight clusters for fodder and seed yield and its related traits in combined forms on pooled basis. Cluster III having the maximum number of accessions followed by cluster VII, VI, I, II, VIII and V, whereas cluster IV was monogenotypic comprising of genotype African Tall only. It is envisaged that the accessions grouped within a population cluster are more or less genetically similar to each other. Thus, genetic stock under study possessed considerable diversity for different traits, which could be exploited. this results was also supported by Alom et al. (2003).

It was interesting to note that many accessions originating from one region were scattered over different clusters. This indicated that there was substantial genetic diversity among the accessions. Such genetic diversity among the genetic lines of common geographic origin could be due to factors like heterogeneity, genetic architecture of the population, past history of selection and developmental traits (Murty and Arunachalam 1966). On the other hand some accessions belonging to same eco-geographical areas were included in the same cluster. This indicated that there is no association between clustering pattern and eco-geographical distribution of genetic lines. Hence, it seems that geographical diversity is not necessarily related to genetic diversity. These findings are in consonance with Cruz *et al.* (1994), Cruz *et al.* (1994a) and Katiyar *et. al.* (2000).

The clustering of accessions from different eco-geographical locations into one cluster could be attributed to possible free exchange of breeding materials or even varieties from one place to another (Sharma and Hore,

1997). This may also be due to the fact that the unidirectional selection practiced for a particular trait in several places produced similar phenotypes, which were aggregated in one cluster irrespective of their geographic origin.

The main objective of forming cluster and to find out the inter and intra-cluster distance is to provide relevant information for selection of diverse parents for hybridization programme without making actual cross (Bhatt, 1970). The average genetic distance for all possible pairs of combinations ranged from 2.824 to 20.971. The inter cluster distance was higher than the intra- cluster distance in all the cases indicating more divergence of accessions between the clusters. The lesser magnitude of intra- cluster distance than those of inter- cluster distance indicated that the accessions grouped in a common cluster diverged very little among themselves as compared to the accessions of different cluster. Large inter- cluster distance signified that the accessions grouped in one cluster are vastly different from the accessions of other clusters for one or more characters, which made them so divergent from others.

Maximum cluster mean was observed in cluster IV, which was monogenotypic (African Tall) having more mean than other cluster for all traits studied, except for leaf- stem ratio, crude protein content and number of kernel rows. The study revealed that all the genetic lines showed lesser dry fodder yield and seed yield as compared to African Tall. Malaviya et al. (2002) reported lesser fodder yield as compared to African Tall in lines studied. Whereas amongst the accessions maximum cluster mean was observed in cluster II for plant height, leaf length, sheath length, leaf width, stem girth and dry fodder yield but these were late in days to 50% silk and maturity.

Maximum crude protein content was recorded for cluster I having less days to 50% silking. Cluster III having average performance and cluster V showed maximum leaf stem ratio and number of kernel rows with less days to 50% silk. Cluster VI was rich in test weight with maximum days to 50% silk and kernel width. Whereas cluster VII was having maximum seed yield with maximum Cob length and number of kernels/ row. Cluster VIII had maximum number of leaves/ plant, Cob width and kernel length. These clusters could be regarded as useful source of genes for different traits and there is sufficient scope for varietal improvement through hybridization. These results also

indicate that if we take one representative accession from each cluster and make a diallel, then in the progeny we can get better heterotic effects and more variability in F_2 populations that will be helpful in selection and breeding programme.

Crosses among parents having genetic divergence are likely to yield desirable combinations. Therefore, a crossing programme should be initiated between the genetic lines belonging to different clusters. Two important factors to be considered are (i) choice of particular cluster from which accessions are to be used as parents in crossing scheme, and (ii) selection of particular accession from selected groups. Results clearly showed that none of the clusters had even a single strain possessing the entire desired characteristic for fodder, seed or for fodder cum seed. Similarly, the accession falling under same cluster/ group belonging to different place, which indicates that no character could be stated restricted to a particular geographical boundary.

Isozymes have been used in genome mapping, population and evolutionary studies, quantification of interrelationship with quantitative traits, identification of varieties, genetic resource management and breeding. Isozymes are more independent of the environmental variations compared to the quantitative traits. As they are not being put to selection pressure over generations (since functionally all forms of these isozymes are identical), their flow over generations are simply the consequence of the hybridization and selection occurring for other traits that may be dependent on the environment, physiological and agronomical features of the genotype. This study was conducted to identify the pattern of variation for isozymes in the background of the apparent genetic diversity observed across regions in the germplasm accessions studied for diversity in fodder and seed traits. Isozyme studies based on their electrophoretic phenotypes (EPs) have gained widespread acceptance and the developments in mathematical and statistical analyses of characterization have allowed their use in inferring life history traits (Donoghue, 1989; Harvey and Kaymer, 1991).

The three isozymes included in this study are Esterase, Peroxidase and Superoxide desmutase. Out of these three, maximum polymorphism was observed for esterase and peroxidase. The study for esterase enzyme

showed presence of 12 distinct migration zones. The study for the SOD showed only four migration zone of which only one was polymorphic. In case of peroxidase, 10 polymorphic bands were recorded with 12 distinct migration zones. First and third migration zones were visible in each accession while 7, 8 and 9 migration zones were comprised of only single band.

UPGMA based dendrogram in dicated that there was no relationship among eco-geographical and isozymes diversity. However, generally, accessions from the same state tend to be together. But the accessions namely IC- 334836 and IC- 334853 were relatively far apart which was also reflected in the non-hierarchical Euclidean cluster analysis.

5.3 Correlation and Path-Coefficient Analysis

Yield, being a complex character, is the cumulative and interactive effect of number of component traits. So, improvement in yield whether it is for fodder yield or seed yield depends on improvement of those component characters. However, because of their complex interactive nature with each other, knowledge of the association of these component traits with yield and among themselves is of utmost importance. Grafius (1959) strongly advocated the use of component breeding approach in order to achieve further improvement in yield whether it is for fodder or grain but not the yield directly as such. In an efficient breeding programme specially for selection information about nature of the gene expression for various component characters, which is likely to change with the changes in environments, is important. Consequently, the associations between yield and the particular component characters as well as amongst the yield components themselves are also likely to change to a greater or lesser extent depending upon the environments. Therefore, it becomes imperative to understand the nature and magnitude of character associations under varying environmental conditions with respect to fodder and seed yield as well as to the quality characters.

Green fodder yield per plant had positive and significant association with sheath length, dry fodder yield, days to 50% silking, number of leaves/plant, plant height, stem girth, leaf blade length and with leaf width and are in accordance with earlier reports of Gurrath et. al. (1989) and Geiger et.

al. (1992). Paramathma and Balasubramanian (1986) have also reported that stem girth, plant height and leaf width are important traits for improving fodder yield. Similarly, Patel and Shelke (1984) reported that leaf area and stem girth have significant positive effect towards fodder yield in maize. Kumar (1982) reported that forage yield was highly correlated with leaf length, leaf number, leaf width and plant height. Crude protein had highly significant negative correlation with green fodder yield. This was in consonance with the findings of Katiyar and Choudhary (1999). Almost, similar findings were found for dry fodder yield/plant. Leaf-stem ratio has positive and significant association with stem thickness, while it was negative with dry fodder yield/plant. Patel and Shelke (1988) reported leaf-stem ratio had no significant relationship with stem girth and dry matter yield/plant.

Phenotypic correlation showed that seed yield was found to be significantly and positively correlated with 100-seed weight, number of kernels/row, kernel width, kernel length, shank diameter and Cob length. Therefore, more emphasis must be given to these component characters for improving cultivars for seed yield. This was in consonance with the findings of Singh (1970), Sviridov (1979), Debnath and Khan (1991), Angelan (1992), Altinbas and Algan (1993), Singh and Major (1993), Krishnan and Natarajan (1995) and Rana *et. al.* (2000).

As far as the phenotypic association between dry fodder and seed yield/plant and their contributing characters are concerned, the dry fodder yield per plant showed significant positive association with seed yield/plant and its contributing traits like days to maturity, 100 seed weight, kernel length and Cob length. Therefore, selection could be practiced among maize lines to develop dual-purpose varieties by selecting of plant with more days to maturity, 100 seed weight, kernel length and more Cob length alone or jointly which increase the level of fodder and seed yield per plant. Number of leaves/plant, days to 50% silking, plant height, stem girth, sheath length, leaf length and leaf width exhibited positive and significant associations with test weight. Leaf-stem ratio and crude protein content had no significant correlation with seed yield and its component traits.

Seed yield/plant had significant and positive correlation with dry fodder yield/plant but it had no significant correlation with other dry fodder yielding

traits. Thus, results of the present study appear to be similar to findings of Laszlo *et. al.* (1969), Fairey (1980), Dubar and Waligora (1984) and Lu Hung Shung *et. al.* (1996).

Fodder or seed yield is the ultimate product of interactions among its attributes under the influence of environment. These interactions lead to indirect effects of these attributes apart from their direct contribution towards green fodder, dry fodder as well as seed yield. Therefore, to determine the interrelationships between both complex characters on the one hand and among their component characters on the other, it seems necessary to understand their direct and indirect effects on yield. It is quite likely that the contribution of a component trait showing highly significant association with yield may get diluted through interactions with the other component characters. Further, the information on relative contribution (direct and indirect) of the component characters to green fodder, dry fodder and seed yield helps the breeders in deciding the appropriate weight age to be given to each related trait during selection. So the simple correlation does not clarify the extremely complex inter-relationships between various characters, which are all related to a dependent variable. Many of the characters are correlated because of the mutual positive or negative association with other characters or with the increase in the number of variables. Thus indirect associations become more complex. In such situations, path coefficient analysis, which provides information on direct and indirect causes of association, permits a critical examination of the specific forces acting to produce a given correlation and measures the relative importance of each causal factor.

The information derived from the correlation studies indicated only the mutual associations among the characters. Whereas, path coefficient analysis helps in understanding the magnitude of direct and indirect contribution of each character on the dependent characters like dry fodder yield and seed yield. Partitioning of correlation coefficient into direct and indirect effects provides the information about the nature and magnitude of effects of other characters on both fodder and seed yield. The results of the present investigation on path analysis revealed that the character like plant height, days to 50% silking, stem thickness, leaf length, leaf width and number of leaves had positive direct effect on dry fodder yield at phenotypic level. But all

these characters also had large positive indirect effects on dry fodder yield through each other. Sheath length had no major direct effects towards dry fodder yield but it was indirectly correlated through plant height. These results are in conformity with the findings of Katiyar and Choudhary (1999).

Among the seed yield contributing traits like 100-seed weight, number of kernels/row, shank diameter, kernel width and Cob width had positive and direct effect on seed yield/plant. Whereas, number of leaves/plant, Cob length and dry fodder yield/plant depict negative direct effects with seed yield. Further, results indicated that shank diameter showed indirect contribution to yield, Cob width and kernel length had indirect significant positive effect on yield via test weight. These result supported by the earlier findings of Singh and Major (1993) and Mani *et. al.* (1999).

In the light of above findings, it may be concluded that the fodder and seed yield attributes as well as quality characters have different kind of associations between and within the complex characters. From the results, it is clear that sheath length, days to 50% silking, number of leaves/plant, plant height, stem girth, leaf blade length, leaf width, days to maturity, 100-seed weight, kernel length and Cob length are comparatively more important characters for green and dry fodder yield as well as seed yield. Therefore, an ideal plant type in maize can be described as one which characterized by tall nature with more days to 50% silking and maturity, more stem girth, leaf blade length and leaf width, test weight and kernel and Cob length. The improvement and selection based on these characters would result not only increase in green and dry fodder yield but also seed yield.

5.4 Stability analysis

Forage crops are generally grown as per specific needs under diverse ecological conditions and the management systems. Frankel (1958) pointed out that for developing varieties better adapted to changing environmental conditions, the plant breeder has to face the choice of breeding for either closely defined ecological conditions or for the more extensive conditions having considerable range of environments. It is now fairly understood that different varieties of crops vary greatly in their response to a wide range of

environments and that the stability in production is the property of a specific genotype. This was demonstrated by Paxman (1956) in *Nicotiana rustica*, Finlay and Wilkinson (1963) in barley and Eberhart and Russell (1966) in maize.

Hence, the important conclusion, which has emerged out, is that the bulk of genotype x environment interaction is often a linear function of environmental means, although both linear and non-linear function played an important role in building up of the total genotype x environment interactions. The range of genotypes could provide an efficient tool to measure and grade a series of environments. In order to get the unbiased estimates of stability parameters, the genotypes must be grown in adequate number of environments covering the range of environmental conditions (Eberhart and Russell, (1966).

In present investigation, the analysis of variance on one hundred and one accessions including African Tall over three environments were analyzed for fodder, seed as well as quality employing the method suggested by Eberhart and Russell (1966). The analysis of variance was carried out for each trait separately for each environment and over the environments.

For estimating the effect of varying environments on performance of the genotypes and to estimate the stability parameters of individual genotype, two different approaches, viz. pooled analysis of variance and regression analysis of the phenotypic stability were adopted. The environmental effects were partitioned into linear and non-linear components. The stability parameters are associated with each of these components. The regression coefficients (bi) is associated with linear components and mean sum of squares for G x E (linear) represents deviation of individual regression line above on or below the average regression line. The S^2di is associated with the non-linear components and mean sum of square for pooled deviation representing deviation from individual regression lines.

Results showed significant difference amongst accessions for all characters. The environment (linear) and pooled deviation were significant for all fodder yield characters and genotype x environment (linear) were also significant for all traits except days to 50% silking, number of leaves/plant, leaf blade length, stem thickness and leaf-stem ratio. For seed traits, environment

(linear) were non-significant for only Cob length whereas, genotype x environment (linear) were significant only for days to maturity and seed yield/ plant. Pooled deviations were significant for all traits. Mahajan et al. (1991) also reported similar results.

In the study of many workers, it has been revealed that even for the unpredictable characters, prediction can still be made when one considers stability parameters of individual accession. Based on this study (Table 5.3 and 5.4) the performance of majority of accessions was predictable for all fodder and seed traits. The discrepancy might be due to the differential testing procedures in the analysis. However, green fodder yield/ plant exhibited unpredictable behavior for most of accessions. Nearly 45% accessions showed predictable behaviour for green fodder yield/ plant.

The present study helped to identify some accessions, which could be suitable for different kinds of environmental conditions. The selected accessions are likely to give predicted response for green and dry fodder yield in a given environment. According to Eberhart and Russell (1966) a desirable

Table 5.3 Distribution of different accessions on the basis of different stability parameters for various fodder characters in maize.

Sr. No.	Characters	Predictable		Unpredictable	
		Both bi & S^{-2}di non- significant	Only bi significant	Both bi & S^{-2}di significant	Only S^{-2}di significant
1	Days to 50%silking	72+African Tall	9	3	16
2	Plant height (cm)	71+African Tall	23	1	5
3	No. of leaves/ plant	69+African Tall	23	3	5
4	Leaf length (cm)	64	31+ African Tall	3	2
5	Sheath length (cm)	64+ African Tall	35	0	1
6	Leaf width (cm)	50	51+ African Tall	0	0
7	Stem girth (cm)	74+ African Tall	18	2	6
8	Green fodder yield/ plant (g)	25	20+ African Tall	17	38
9	Dry fodder yield/ plant (g)	33+ African Tall	29	19	19
10	Leaf - Stem ratio	53	44+ African Tall	2	1
11	Crude protein (%)	54	42+ African Tall	2	1

Table 5.4 Distribution of different accessions on the basis of different stability parameters for various seed characters in maize.

Sr. No.	Characters	Predictable		Unpredictable	
		Both bi & $S^{2}di$ non- significant	Only bi significant	Both bi & $S^{2}di$ significant	Only $S^{2}di$ significant
1	Days to maturation	54+ African Tall	5	2	39
2	Ear length	69+ African Tall	16	5	10
3	Ear width	72+ African Tall	22	1	5
4	Number of kernel rows	83+ African Tall	17	0	0
5	Number of kernels/ row	83+ African Tall	12	0	5
6	Shank diameter	67+ African Tall	32	0	2
7	Kernel length	68+ African Tall	29	1	2
8	Kernel width	68+ African Tall	29	1	2
9	100-seed weight	47+ African Tall	18	7	28
10	Seed yield/ plant	46+ African Tall	28	11	15

variety is one that has high mean with unity regression coefficients and $S^{2}di$ values approaching to zero.

The accessions were grouped on the basis of three stability parameters like mean (x), regression coefficient (bi) and mean square deviation ($S^{2}di$). Out of one hundred and one accessions, none of the accession was found to be stable for all the characters studied. Hence a comparative statement for stability parameters was made to sort out the promising high yielding stable accessions with respect to fodder, quality and seed yield trait components.

In the present study, accession IC-334834, IC-334841, IC-334872, IC-334915, IC-334920, IC-334945, IC-335043, IC-335164 and African Tall were found to be stable and high yielding for both green and dry fodder/ plant, while IC-334474 had below average dry fodder yield. Out of stable and high fodder yielding accessions, IC-334945 and African Tall were found to be poor in protein content as compared to other accessions. Amongst seed yield traits, almost all accessions were found stable except IC-334974 and IC-334872,

which were found to be unstable. Out of stable accessions, IC-334974, IC-335043 and African Tall were found to be rich in seed yield/ plant. Similar results were reported by Gamma and Hallauer (1980), Jha et al. (1986) Sain *et al.* (1987), Mahajan and Khehra (1992), V'Lchinkov (1992), Pal and Prodhan (1994), Sedham (1994), Paradkar *et al.* (1995), Gautam *et al.* (1998), Reddy *et al.* (1998) and Nirala and Jha (2003). Based on above results, it is suggested that above-mentioned germplasm lines may be utilized in future breeding programme in order to improve the fodder and seed yield as well as quality characters in maize.

Table 5.5 Directory of promising accessions with respect to stability parameters for fodder yield, quality and seed yield traits.

Characters	Stability parameters	Accessions									
		IC-334834	IC-334841	IC-334872	IC-334915	IC-334920	IC-334945	IC-334974	IC-335043	IC-335164	African Tall
Green fodder yield/ plant (g)	M	AA	AA	AA	AA	A	AA	AA	AA	AA	AA
	R	AA	AA	AA	AA	BA	AA	AA	AA	AA	AA
	S	S	S	S	S	S	S	S	S	S	S
Dry fodder yield/ plant (g)	M	AA	AA	AA	AA	A	AA	BA	AA	AA	AA
	R	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA
	S	S	S	S	S	S	S	S	S	S	S
Crude protein content (%)	M	A	AA	A	AA	AA	BA	AA	AA	AA	BA
	R	AA	AA	AA	BA	AA	AA	AA	BA	AA	BA
	S	S	S	S	S	S	S	S	S	S	S
Seed yield/ plant (G)	M	A	A	BA	BA	BA	A	AA	AA	BA	AA
	R	AA	BA	AA	AA	AA	BA	BA	BA	AA	AA
	S	S	S	US	S	S	S	US	S	S	S

M = mean; R = response; S = stable; US = unstable; A = average; AA = above average and BA = below average

Chapter - VI
Summary

SUMMARY

Maize (*Zea mays* L.) belongs to the grass family, Poaceae (syn. Gramineae), subfamily, Panicoideae, which includes the majority of grasses in tropical and sub-tropical regions throughout the world. Whereas most grasses have perfect flowers. Maize is a monoecious plant and It develops inflorescence with unisexual flowers that are always borne in separate parts of the plant. Maize is one of the few food plants that is diploid with a basic set of ten chromosome ie. 2n= 20.

Maize, a nutritious cereal is used for human consumption besides feed and fodder. In spite of many beneficial uses, it has not so far received adequate attention from the point of view of fodder genetic improvement and management. The crosses involving diverse parents are expected to generate considerable amount of genetic variability, in order to select diverse parents from existing genetic stock stratification of diversity is important. The nature and magnitude of various genetic parameters, character association and G x E interaction under changing environments serves as complementary information.

In the present study a core collection comprising of one hundred genetic lines of diverse origin were collected from the maize genetic stock being maintained at Gene Bank of Indian Grassland and Fodder Research Institute (IGFRI), Jhansi. These representatives were initially collected from the state of Madhya Pradesh, Rajasthan and Uttar Pradesh. The crop accessions were evaluated against the check variety African Tall in randomized block design with three replication during three consecutive years 2001-2003 in Kharif season.

Each entry was replicated thrice in two rows of 4 m length keeping 0.50 m distance between the rows and 0.15 m between the plants. Standard agronomic practices were followed and recommended fertilizer dose were applied during the course of experiment. Observations on three randomly selected plants from each accession in each replication of each environment were recorded for days to 50% silking. plant height (cm), leaf blade length (cm), sheath length (cm), leaf width (cm), stem girth (cm), green fodder yield/plant (g), dry fodder yield/plant (g), leaf-stem ratio, crude protein content (%), days to maturity, cob length (cm), cob width (cm), number of kernel rows, kernels per/ row, kernel length (cm), kernel width (cm), 100-seed weight (g) and seed (kernel) yield/plant (g). The data of three environments were pooled and subjected to estimate the genetic variability, genetic divergence, character association and phenotypic stability of various fodder, and seed yield traits with the help of statistical procedures. The salient findings of this study are summarized as under following sections:

Analysis of variance showed considerable genetic variation in the accessions for different fodder and seed yield characters and its component traits. The potential of the accessions with respect to various traits was studied, and a number of potential strains for fodder, seed and fodder cum seed yield and quality traits were identified for their exploitation in future breeding programmes.

Visual parameters (qualitative traits) showed maximum number of accessions with dark green colour of sheath and leaf blade. There was no colour variation in midrib colour while maximum number of accessions was showing light green stem colour. Among seed traits, maximum number of accessions with light yellow kernel, regular kernel row arrangement, medium size with shrunken kernels and cylindrical cob shape. On the basis of mean performance of each accession, five major classes were formed and the maximum number of accessions was placed in class II followed by class III for most of the traits.

Considering mean performance of the accessions, the accession IC-335056 and IC-334973 were observed to be earliest for days to 50% silking as they flowered in 43 and 48 days respectively, whereas, the genotype African Tall and IC-334833 were considered late in this trait as they flowered in 59 and 54 days respectively. For plant height African Tall and IC-334855 were found to be taller as compared to others. The accessions identified, as dwarf in plant height are IC-335060 and IC-335056. The genotype producing maximum number of leaves is African Tall and IC-335035. Maximum green fodder yield was observed in genotypes like African Tall and IC-334846 whereas maximum dry fodder yield was recorded for African tall and IC-334833.

Being a cereal crop, maize is not rich in protein content, however, few accessions like IC-334841 and IC-334920 were identified to be very promising as they contain about 11.0 -12.24% crude protein whereas African Tall had very low crude protein content (8.66%) amongst the accessions evaluated.

Among the seed yield traits, the germplasm lines like IC- 335111 and IC-335069 were found as early maturing type, whereas, African Tall and IC-334904 were found late in maturity. Maximum cob length was recorded for African Tall and IC-335024. Maximum cob width was reported for IC-334932 and IC-334877. IC-334942 and IC-334947 was rich in number of kernel rows and Maximum kernels/ row was observed in IC-335094 and IC-335120. Biggest shank size was observed in African Tall and followed by IC-334996. Accessions like IC-334954 and IC-334853 had highest kernel length while IC-334869 and IC-334846 were found with highest values for kernel width. Maximum test weight was recorded for African Tall and IC-334853. African Tall also showed maximum seed yield/plant followed by IC-335024.

High genotypic coefficient of variation was observed for green fodder yield/plant whereas it was moderate for dry fodder yield/plant. Similarly, among seed yield traits genotypic coefficient of variation was high for number of

kernels/row and moderate for seed yield/plant. There was a close relationship between phenotypic and genotypic coefficient of variation in almost all the characters. However, phenotypic coefficient of variation was slightly higher than their corresponding genotypic coefficient of variation.

For fodder yield and its contributing traits, the range of heritability (broad sense) estimates were high as compared to seed characters. Among fodder traits the highest heritability was observed for green fodder yield, dry fodder yield and days to 50% silking. The remaining characters showed low to medium level of heritability. Similarly in case of seed traits and its contributing traits, days to maturity along with days to 50% silking were showing high level of heritability.

Expected genetic advance for various traits showed that green fodder yield/ plant exhibited the highest genetic advance and the moderate values of genetic advance was showed by plant height and dry fodder yield/ plant. The remaining characters were showing low to very low genetic advance. Similarly for seed traits it was high to number of kernels/ row, days to maturity and seed yield/ plant.

The analysis of genetic divergence through non-hierarchical Euclidean cluster analysis revealed considerable genetic diversity among the accessions. Entire number of evaluated accession were grouped into eight clusters for fodder and seed traits as well, in combined form. Among eight clusters, cluster III comprised of 26 accessions was identified as the largest group followed by cluster VII which included 19 accessions. Cluster V was noticed as digenotypic and cluster IV as monogenotypic. Accessions belonging to same eco-geographical regions were scattered over different clusters showing substantial genetic diversity.

The intra-cluster distances were relatively smaller than inter-cluster distances showing homogenous nature of groups and presence of narrow

genetic variation within a cluster. The maximum inter-cluster distance was observed between cluster IV and V followed by I and IV, III and IV, IV and VII, IV and VI and II and IV. The use of accessions in hybridization from these clusters having most of the desirable characters is likely to produce more transgressive segregants.

The accessions belonging to cluster IV had the highest dry fodder yield as well as seed yield. Days to 50% silking and maturity were found short for clusters V while they were prolonged for cluster IV. The accessions belonging to cluster IV had taller plants, long leaf blade length and sheath length, wide leaf width and thick stem. Cluster IV showed highest values for leaf-stem ratio and crude protein content were higher for cluster I.

Of the three isozymes used for the assay, maxiumum polymorphism was observed for the esterase and peroxidase isozymes UPGMA based dendrogram indicated that there was no relationship among geographical, agronomic and isozyme diversity. However, generally, accessions from the same state tend to be together. IC- 334836 and IC- 334853, both from Rajsamand (Rajasthan) were relatively far apart which was also reflected in the cluster analysis. It was also evident that accessions belonging to the same cluster based on quantitative fodder and seed yield trait had no corresponding placement in the isozyme based dendrogram.

Estimates of phenotypic correlation coefficients revealed dry and green fodder yield/plant was found to be positive and significantly correlated with each other and their contributing traits like days to 50% silking, plant height, number of leaves/plant, leaf blade length, sheath length, leaf width and stem thickness. Similarly for seed yield, it was positive and significantly associated within order 100-seed weight, number of kernels row, kernel width, kernel length, shank diameter and cob length.

When fodder and seed yield components considered together, dry fodder yield had positive and significant correlation with the seed yield/plant and its contributing traits like days to maturity, 100-seed (kernel) weight. Kernel length and cob length. Similarly, component characters of seed yield per plant were also correlated with fodder traits like number of leaves per plant, days to 50% silking, plant height, stem girth, sheath length, leaf length, leaf width and 100-seed (kernel) weight. Where these traits were positive and significantly associated with various seed yielding characters.

Path-coefficient analysis further confirmed that the characters like days to 50% silking, plant height, number of leaves/plant, leaf length, sheath length, leaf width and stem girth were the major component traits of dry fodder yield. Whereas, for seed yield these components were number of leaves/ plant, dry fodder yield/plant, cob length, cob width, number of kernels/row, shank diameter, kernel length, kernel width and 100-seed weight.

Analysis of variance of 101 maize accessions over three environments carried out for important fodder, seed and quality characters showed significant difference amongst the accessions for these characters. Further, the environment (linear), genotype x environment (linear) components of variance and the pooled deviations were also significant which showed that accessions could not maintain consistency in performance with respect to these characters as such there is a need for studying stability of the individual accession.

The estimation of stability parameters for individual accession indicated that the proportion of accessions exhibiting predictable behaviour was more for stem girth, days to 50% silking and plant height for fodder yield and for seed yield these traits were number of kernel rows, number of kernels/ row and cob width.

The accession like IC- 334834, IC- 335164, IC- 334872 and African Tall were found stable with promise for yield potential of green as well as dry fodder/

plant. Amongst the seed yielding traits, all accessions were stable for this trait except IC- 334974, IC- 334872 and IC- 334887. Out of stable accessions IC-334974, IC- 335043 and African Tall were having maximum seed yield/ plant.

Thus, the present study was a successful attempts in identifying the elite accessions based on genetic variability, divergence, stability, their performance and the understanding of complex interrelationship among attributes involved in genetic control of fodder, seed yield and quality of maize. The results will provide valuable guidelines in planning future breeding programmes for improving fodder yield, seed yield and quality in order to enhance over all quality forage production and / or to develop dual-purpose materials in maize.

Chapter - VII
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APPENDIX - I

Quality performance of different accessions for various fodder and seed yield characters

S. No.	Accession No.	District	State	Leaf blade colour	Sheath colour	Midrib colour	Stem colour	Kernel colour	Kernel row arrangement	Kernel shape	Kernel size	Ear shape
1.	IC- 334821	Jaipur	Raj.	DG	DG	White	LG	DY	Regular	Shrunken	Medium	Cylindrical
2.	IC- 334825	Rajsamand	Raj.	DG	DG	White	LG	DY	Straight	Shrunken	Small	Cylindrical
3.	IC- 334826	Rajsamand	Raj.	DG	DG	White	LG	DY	Straight	Shrunken	Medium	Cylindrical
4.	IC- 334830	Rajsamand	Raj.	DG	DG	White	LG	V	Irregular	Round	Bold	Conical
5.	IC- 334833	Rajsamand	Raj.	DG	DG	White	LG	W	Straight	Shrunken	Bold	Cylindrical
6.	IC- 334834	Rajsamand	Raj.	DG	DG	White	LG	W	Straight	Shrunken	Bold	Conical
7.	IC- 334836	Rajsamand	Raj.	DG	DG	White	LG	W	Irregular	Shrunken	Medium	Conical
8.	IC- 334837	Rajsamand	Raj.	DG	DG	White	DG	DY	Regular	Shrunken	Medium	Cylindrical
9.	IC- 334838	Rajsamand	Raj.	DG	DG	White	LG	DY	Regular	Shrunken	Bold	Cylindrical
10.	IC- 334841	Rajsamand	Raj.	DG	LG	White	DG	LY	Regular	Shrunken	Medium	Cylindrical
11.	IC- 334842	Rajsamand	Raj.	LG	DG	White	LG	DY	Straight	Shrunken	Bold	Cylindrical
12.	IC- 334846	Rajsamand	Raj.	DG	LG	White	LG	W	Straight	Shrunken	Bold	Cylindrical
13.	IC- 334848	Rajsamand	Raj.	DG	DG	White	LG	W	Irregular	Shrunken	Medium	Conical
14.	IC- 334853	Rajsamand	Raj.	DG	DG	White	LG	W	Straight	Shrunken	Bold	Cylindrical
15.	IC- 334855	Udaipur	Raj.	DG	DG	White	LG	W	Straight	Shrunken	Bold	Cylindrical
16.	IC- 334863	Udaipur	Raj.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
17	IC- 334864	Udaipur	Raj.	LG	DG	White	LG	W	Irregular	Shrunken	Medium	Cylindrical
18.	IC- 334867	Udaipur	Raj.	DG	LG	White	LG	V	Straight	Shrunken	Bold	Conical
19.	IC- 334869	Sirohi	Raj.	DG	DG	White	LG	V	Straight	Shrunken	Bold	Conical
20.	IC- 334871	Sirohi	Raj.	DG	DG	White	LG	DY	Spiral	Shrunken	Bold	Conical
21.	IC- 334872	Sirohi	Raj.	DG	LG	White	LG	DY	Regular	Round	Small	Conical
22.	IC- 334876	Sirohi	Raj.	DG	DG	White	LG	V	Straight	Shrunken	Bold	Conical
23.	IC- 334877	Sirohi	Raj.	DG	DG	White	LG	DY	Straight	Shrunken	Small	Conical
24.	IC- 334879	Sirohi	Raj.	LG	LG	White	LG	DY	Regular	Shrunken	Medium	Cylindrical

LG = Light green, DG = Dark green, Y = Yellow, LY = Light yellow, DY = Dark yellow, W = White, V = Variegated

S. No.	Accession No.	District	State	Leaf blade colour	Sheath colour	Midrib colour	Stem colour	Kernel colour	Kernel row arrangement	Kernel shape	Kernel size	Ear shape
25.	IC- 334880	Sirohi	Raj.	DG	LG	White	LG	W	Spiral	Shrunken	Bold	Cylindrical
26.	IC- 334881	Sirohi	Raj.	DG	LG	White	LG	W	Straight	Shrunken	Medium	Cylindrical
27.	IC- 334884	Sirohi	Raj.	LG	DG	White	LG	DY	Regular	Shrunken	Medium	Cylindrical
28.	IC- 334889	Dungarpur	Raj.	LG	LG	White	DG	DY	Regular	Shrunken	Medium	Conical
29.	IC- 334904	Banswara	Raj.	DG	DG	White	LG	V	Straight	Shrunken	Small	Conical
30.	IC- 334915	Banswara	Raj.	DG	LG	White	LG	Y	Regular	Shrunken	Bold	Conical
31.	IC- 334920	Ratlam	Raj.	LG	LG	White	DG	DY	Straight	Round	Medium	Cylindrical
32.	IC- 334929	Ratlam	Raj.	DG	DG	White	LG	Y	Regular	Shrunken	Bold	Conical
33.	IC- 334932	Ratlam	Raj.	DG	DG	White	DG	DY	Regular	Shrunken	Bold	Cylindrical
34.	IC- 334942	Ujjain	M. P.	DG	DG	White	LG	LY	Regular	Round	Small	Conical
35.	IC- 334943	Ujjain	M. P.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
36.	IC- 334944	Ujjain	M. P.	LG	DG	White	LG	V	Straight	Shrunken	Medium	Conical
37.	IC- 334945	Ujjain	M. P.	DG	LG	White	DG	DY	Regular	Shrunken	Small	Conical
38.	IC- 334947	Sajapur	M. P.	DG	DG	White	LG	DY	Regular	Shrunken	Medium	Cylindrical
39.	IC- 334949	Sajapur	M. P.	DG	LG	White	DG	V	Straight	Shrunken	Bold	Conical
40.	IC- 334954	Jhalawar	Raj.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
41.	IC- 334955	Garhi	Raj.	DG	DG	White	DG	LY	Irregular	Shrunken	Small	Cylindrical
42.	IC- 334957	Garhi	Raj.	DG	DG	White	LG	W	Irregular	Shrunken	Bold	Cylindrical
43.	IC- 334973	Kannauj	U. P.	DG	LG	White	LG	W	Irregular	Shrunken	Medium	Conical
44.	IC- 334974	Kannauj	U. P.	LG	DG	White	LG	Y	Straight	Shrunken	Bold	Conical
45.	IC- 334989	Kannauj	U. P.	DG	LG	White	DG	LY	Straight	Round	Small	Cylindrical
46.	IC- 334996	Kannauj	U. P.	LG	DG	White	LG	DY	Regular	Round	Medium	Cylindrical
47.	IC- 334999	Kannauj	U. P.	DG	LG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
48.	IC- 335000	Kannauj	U. P.	DG	LG	White	LG	Y	Regular	Shrunken	Medium	Conical
49.	IC- 335009	Farrukhabad	U. P.	DG	LG	White	DG	LY	Regular	Shrunken	Medium	Cylindrical
50.	IC- 335017	Farrukhabad	U. P.	DG	DG	White	DG	LY	Irregular	Shrunken	Bold	Conical
51.	IC- 335024	Farrukhabad	U, P.	DG	DG	White	DG	LY	Straight	Round	Medium	Conical
52.	IC- 335025	Farrukhabad	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
53.	IC- 335027	Farrukhabad	U. P.	DG	DG	White	LG	W	Spiral	Shrunken	Medium	Cylindrical

LG = Light green, DG = Dark green, Y = Yellow, LY = Light yellow, DY = Dark yellow, W = White, V = Variegated

S. No.	Accession No.	District	State	Leaf blade colour	Sheath colour	Midrib colour	Stem colour	Kernel colour	Kernel row arrangement	Kernel shape	Kernel size	Ear shape
54.	IC- 335028	Farrukhabad	U. P.	DG	DG	White	LG	LY	Regular	Round	Medium	Conical
55.	IC- 335032	Farrukhabad	U. P.	DG	DG	White	DG	LY	Regular	Shrunken	Bold	Conical
56.	IC- 335035	Farrukhabad	U. P.	LG	DG	White	LG	V	Regular	Shrunken	Medium	Cylindrical
57.	IC- 335041	Farrukhabad	U. P.	DG	DG	White	LG	Y	Straight	Pointed	Bold	Cylindrical
58.	IC- 335043	Farrukhabad	U. P.	DG	LG	White	LG	LY	Irregular	Shrunken	Medium	Conical
59.	IC- 335045	Farrukhabad	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
60.	IC- 335048	Farrukhabad	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
61.	IC- 335050	Farrukhabad	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
62.	IC- 335051	Farrukhabad	U. P.	DG	LG	White	DG	DY	Regular	Shrunken	Bold	Cylindrical
63.	IC- 335053	Hardoi	U. P.	DG	DG	White	DG	LY	Straight	Round	Small	Conical
64.	IC- 335056	Hardoi	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Conical
65.	IC- 335060	Hardoi	U. P.	DG	DG	White	DG	LY	Regular	Round	Small	Conical
66.	IC- 335062	Hardoi	U. P.	LG	DG	White	LG	LY	Regular	Indented	Medium	Cylindrical
67.	IC- 335068	Hardoi	U. P.	LG	LG	White	LG	LY	Regular	Shrunken	Medium	Conical
68.	IC- 335069	Hardoi	U. P.	DG	LG	White	LG	LY	Regular	Shrunken	Small	Conical
69.	IC- 335079	Hardoi	U. P.	DG	DG	White	LG	LY	Regular	Round	Medium	Cylindrical
70.	IC- 335082	Hardoi	U. P.	DG	DG	White	LG	LY	Straight	Shrunken	Medium	Cylindrical
71.	IC- 335086	Hardoi	U. P.	DG	LG	White	DG	LY	Straight	Shrunken	Small	Conical
72.	IC- 335089	Hardoi	U. P.	DG	DG	White	LG	LY	Irregular	Shrunken	Medium	Conical
73.	IC- 335092	Hardoi	U. P.	LG	LG	White	LG	DY	Irregular	Shrunken	Small	Cylindrical
74.	IC- 335094	Hardoi	U. P.	DG	LG	White	DG	LY	Regular	Shrunken	Bold	Conical
75.	IC- 335098	Kannauj	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Bold	Conical
76.	IC- 335103	Kannauj	U. P.	DG	LG	White	LG	W	Straight	Round	Bold	Conical
77.	IC- 335109	Kannauj	U. P.	DG	DG	White	DG	DY	Regular	Shrunken	Medium	Cylindrical
78.	IC- 335110	Kannauj	U. P.	DG	LG	White	LG	Y	Straight	Shrunken	Medium	Cylindrical
79.	IC- 335111	Kannauj	U. P.	DG	LG	White	DG	LY	Regular	Shrunken	Bold	Cylindrical
80.	IC- 335112	Kannauj	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Bold	Cylindrical
81.	IC- 335115	Kannauj	U. P.	DG	LG	White	LG	B	Straight	Round	Small	Cylindrical
82.	IC- 335116	Kannauj	U. P.	LG	DG	White	LG	LY	Regular	Round	Medium	Cylindrical

LG = Light green, DG = Dark green, Y = Yellow, LY = Light yellow, DY = Dark yellow, W = White, V = Variegated

S. No.	Accession No.	District	State	Leaf blade colour	Sheath colour	Midrib colour	Stem colour	Kernel colour	Kernel row arrangement	Kernel shape	Kernel size	Ear shape
83.	IC- 335117	Kannauj	U. P.	DG	LG	White	LG	LY	Regular	Shrunken	Small	Cylindrical
84.	IC- 335120	Kannauj	U. P.	DG	DG	White	LG	LY	Spiral	Shrunken	Medium	Conical
85.	IC- 335122	Kannauj	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
86.	IC- 335128	Kannauj	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Conical
87.	IC- 335131	Kannauj	U. P.	DG	DG	White	LG	Y	Straight	Indented	Bold	Conical
88.	IC- 335138	Kannauj	U. P.	LG	DG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
89.	IC- 335141	Kannauj	U. P.	DG	LG	White	LG	LY	Irregular	Shrunken	Medium	Conical
90.	IC- 335144	Kannauj	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Small	Conical
91.	IC- 335148	Kannauj	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Cylindrical
92.	IC- 335149	Kannauj	U. P.	DG	DG	White	LG	LY	Regular	Shrunken	Medium	Conical
93.	IC- 335152	Kannauj	U. P.	LG	DG	White	LG	DY	Spiral	Shrunken	Small	Conical
94.	IC- 335156	Kannauj	U. P.	DG	LG	White	DG	LY	Regular	Shrunken	Medium	Cylindrical
95.	IC- 335158	Kannauj	U. P.	DG	DG	White	LG	LY	Regular	Round	Medium	Conical
96.	IC- 335164	Kanpur	U. P.	DG	DG	White	DG	LY	Irregular	Shrunken	Medium	Conical
97.	IC- 335169	Kanpur	U. P.	DG	DG	White	DG	LY	Regular	Shrunken	Bold	Conical
98.	IC- 335173	Kanpur	U. P.	DG	DG	White	DG	LY	Regular	Shrunken	Medium	Cylindrical
99.	IC- 335178	Kanpur	U. P.	DG	DG	White	LG	LY	Spiral	Shrunken	Bold	Conical
100.	IC- 335184	Kanpur	U. P.	DG	LG	White	DG	LY	Regular	Shrunken	Medium	Cylindrical
101.	African Tall	-	-	DG	DG	White	LG	DY	Irregular	Shrunken	Medium	Conical

LG = Light green, DG = Dark green, Y = Yellow, LY = Light yellow, DY = Dark yellow, W = White, V = Variegated

APPENDIX - II

Mean performance of different accessions for various fodder yield characters

Sr. No.	Accession No..	Days to 50% silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Green fodder yield/ plant (g)	Dry fodder yield/ plant (g)	Leaf-stem ratio	Crude protein content (%)
1.	IC- 334821	45.00	168.90	9.92	83.96	15.65	7.81	1.85	367.96	67.74	0.41	10.58
2.	IC- 334825	45.67	183.85	11.56	84.36	15.26	8.57	2.05	543.94	105.66	0.23	11.20
3.	IC- 334826	45.00	194.52	11.37	85.55	17.28	8.32	2.23	591.48	94.09	0.37	11.42
4.	IC- 334830	50.33	221.35	13.04	90.81	18.65	9.24	2.26	694.94	115.17	0.35	11.44
5.	IC- 334833	55.22	214.86	13.00	98.37	19.49	9.40	2.36	782.04	130.57	0.39	11.43
6.	IC- 334834	52.78	215.08	12.55	94.83	17.67	9.38	2.34	689.25	120.74	0.36	9.62
7.	IC- 334836	52.89	203.54	12.55	90.70	16.96	9.13	2.20	598.65	92.91	0.49	10.16
8.	IC- 334837	52.22	207.80	12.67	98.44	17.07	9.44	2.07	609.50	104.50	0.37	10.25
9.	IC- 334838	52.67	211.79	11.78	91.09	16.89	9.81	2.31	687.40	98.05	0.33	10.76
10.	IC- 334841	50.33	206.46	13.07	88.35	18.09	9.57	2.23	690.18	106.13	0.35	12.24
11.	IC- 334842	51.67	199.98	13.33	88.43	17.91	9.55	2.28	683.44	112.03	0.37	10.47
12.	IC- 334846	51.56	221.02	12.52	97.00	19.33	9.94	2.33	892.36	128.21	0.32	10.50
13.	IC- 334848	51.33	203.00	12.33	88.65	16.72	9.13	2.37	667.89	106.50	0.37	11.60
14.	IC- 334853	54.33	206.59	12.44	90.62	17.93	8.39	2.06	544.46	98.13	0.42	11.46
15.	IC- 334855	51.11	233.19	13.15	98.83	18.93	8.43	2.24	713.16	120.27	0.39	10.34
16.	IC- 334863	53.78	184.94	12.74	89.04	16.96	8.54	2.24	618.07	95.19	0.46	10.15
17	IC- 334864	49.11	191.52	13.37	84.48	16.87	7.96	2.17	633.24	95.10	0.38	11.34
18.	IC- 334867	52.11	186.13	11.70	87.87	17.53	8.37	2.16	585.14	83.46	0.38	10.43
19.	IC- 334869	50.78	192.59	12.52	86.09	16.86	9.13	2.20	425.42	84.82	0.46	11.11
20.	IC- 334871	51.78	181.59	12.63	90.57	17.80	8.74	1.99	486.92	98.54	0.42	9.02
21.	IC- 334872	51.22	196.08	12.07	97.93	18.61	8.69	2.21	711.59	98.75	0.44	9.73

Sr. No.	Accession No.	Days to 50% silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Green fodder yield/ plant (g)	Dry fodder yield/ plant (g)	Leaf-stem ratio	Crude protein content(%)
22.	IC- 334876	49.89	181.43	13.22	83.04	16.71	8.17	2.17	551.78	89.70	0.40	10.67
23.	IC- 334877	51.89	191.67	11.70	90.84	17.34	7.91	1.98	495.48	88.05	0.40	10.48
24.	IC- 334879	51.44	185.22	12.41	92.57	19.06	8.48	2.04	538.67	103.38	0.33	10.95
25.	IC- 334880	50.67	203.47	12.78	84.95	17.64	8.12	2.08	620.72	96.51	0.39	11.65
26.	IC- 334881	50.56	200.53	12.44	86.07	17.21	8.93	2.02	555.41	101.80	0.44	10.50
27.	IC- 334884	51.22	202.98	12.26	86.67	15.96	8.30	2.14	573.13	92.62	0.32	10.90
28.	IC- 334889	45.22	169.70	12.37	76.91	14.11	7.59	1.80	380.01	55.73	0.55	11.77
29.	IC- 334904	51.44	173.07	12.00	75.62	15.37	8.69	2.22	511.65	76.79	0.46	11.97
30.	IC- 334915	44.22	210.46	12.48	89.11	18.04	8.80	2.11	678.93	111.94	0.33	11.25
31.	IC- 334920	44.67	189.15	11.82	79.29	16.46	8.16	1.97	525.83	90.60	0.33	12.12
32.	IC- 334929	47.67	195.33	12.63	82.65	15.81	8.23	1.98	535.58	95.67	0.38	11.03
33.	IC- 334932	50.56	185.74	13.07	80.61	16.20	10.32	2.09	543.53	97.15	0.45	11.22
34.	IC- 334942	52.67	211.84	13.15	81.57	17.52	7.64	2.10	598.55	118.61	0.32	11.53
35.	IC- 334943	52.44	206.00	13.48	86.75	16.79	8.67	2.23	697.40	108.00	0.36	10.55
36.	IC- 334944	50.33	169.78	11.41	79.18	15.87	8.57	1.94	420.44	72.59	0.41	11.43
37.	IC- 334945	52.89	196.07	12.89	88.11	18.06	9.14	2.33	657.26	100.81	0.44	10.19
38.	IC- 334947	44.89	169.51	11.89	88.74	15.67	7.17	1.86	385.53	95.96	0.31	10.80
39.	IC- 334949	50.56	192.20	12.85	93.78	17.54	8.68	2.06	655.91	94.31	0.45	10.15
40.	IC- 334954	50.78	197.13	12.67	90.56	17.73	7.99	2.14	572.76	95.91	0.40	10.94
41.	IC- 334955	45.22	191.37	11.89	86.60	15.79	8.07	1.80	504.31	100.01	0.30	10.64
42.	IC- 334957	48.44	177.69	11.78	84.78	17.35	7.80	2.03	468.15	81.76	0.43	10.62
43.	IC- 334973	43.22	198.96	11.45	87.49	16.96	7.53	1.88	515.27	76.80	0.46	10.33
44.	IC- 334974	47.22	184.52	12.22	85.02	16.04	8.99	2.10	596.35	81.24	0.43	11.02
45.	IC- 334989	44.89	175.37	11.48	75.87	14.99	6.70	1.82	487.98	88.50	0.29	10.75
46.	IC- 334996	45.56	186.22	10.55	84.28	15.72	7.69	1.84	517.18	107.04	0.28	10.55
47.	IC- 334999	43.33	195.80	11.44	99.00	17.43	8.43	2.11	682.71	106.84	0.36	11.00
48.	IC- 335000	43.78	205.78	11.74	88.04	16.39	7.72	2.15	618.07	113.59	0.29	10.62
49.	IC- 335009	45.67	203.63	12.00	95.35	17.04	8.16	2.08	616.00	97.36	0.42	10.44

Sr. No.	Accession No.	Days to 50% silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Green fodder yield/ plant (g)	Dry fodder yield/ plant (g)	Leaf-stem ratio	Crude protein content(%)
50.	IC- 335017	46.78	194.48	12.15	87.89	16.73	8.03	2.19	700.07	99.38	0.38	10.83
51.	IC- 335024	47.33	195.11	11.92	86.50	16.44	8.14	2.16	559.85	104.40	0.33	10.48
52.	IC- 335025	47.67	178.45	11.93	89.04	16.19	8.56	2.17	498.53	110.34	0.31	11.33
53.	IC- 335027	52.33	170.15	12.33	86.24	16.69	8.44	2.14	567.92	104.54	0.37	10.76
54.	IC- 335028	46.56	191.15	12.22	91.07	16.60	8.35	1.99	610.68	105.51	0.33	10.45
55.	IC- 335032	46.56	210.70	12.89	91.15	17.31	8.49	2.12	664.67	101.82	0.44	10.96
56.	IC- 335035	50.33	212.11	13.63	86.00	18.44	8.41	2.12	667.70	91.92	0.48	10.17
57.	IC- 335041	46.00	203.15	13.33	86.57	16.87	9.04	2.25	673.27	105.47	0.42	10.15
58.	IC- 335043	45.11	185.37	11.15	95.04	17.54	8.63	1.99	576.19	97.16	0.36	11.54
59.	IC- 335045	46.67	180.87	11.15	89.07	16.69	8.42	1.88	532.11	85.84	0.39	10.39
60.	IC- 335048	47.22	201.84	11.81	89.83	17.33	8.36	2.13	600.01	104.40	0.35	9.77
61.	IC- 335050	47.00	199.30	11.74	91.33	17.28	8.41	2.08	585.46	102.78	0.30	9.47
62.	IC- 335051	46.67	189.82	12.33	84.56	16.46	7.30	1.82	449.02	70.60	0.39	11.64
63.	IC- 335053	48.67	177.37	12.93	95.89	17.93	9.24	2.23	784.06	113.31	0.44	10.42
64.	IC- 335056	43.00	153.71	10.81	79.10	15.91	8.22	1.97	353.82	65.41	0.46	10.45
65.	IC- 335060	46.22	148.44	10.18	72.93	13.09	6.44	1.54	278.74	47.91	0.45	11.62
66.	IC- 335062	44.33	156.78	10.00	79.82	14.82	7.08	1.71	357.59	81.33	0.44	11.02
67.	IC- 335068	44.00	157.31	9.89	65.67	14.01	7.47	1.54	208.83	41.57	0.62	10.58
68.	IC- 335069	46.11	154.89	10.11	78.71	15.39	7.83	1.86	399.73	58.70	0.48	10.63
69.	IC- 335079	46.00	161.33	11.04	81.27	15.69	7.57	1.94	465.85	75.78	0.51	10.49
70.	IC- 335082	48.22	166.07	10.63	82.34	14.67	7.68	1.82	418.89	79.35	0.42	11.10
71.	IC- 335086	44.11	154.63	9.81	80.28	15.98	7.81	1.89	479.74	82.29	0.33	11.41
72.	IC- 335089	45.78	189.16	11.70	86.94	18.28	7.44	1.89	565.32	74.16	0.44	11.02
73.	IC- 335092	45.00	181.94	11.22	88.35	16.06	8.30	2.04	575.33	105.17	0.32	10.97
74.	IC- 335094	44.89	188.62	11.19	85.91	16.12	7.70	1.90	535.67	89.31	0.39	10.16
75.	IC- 335098	45.78	173.32	11.41	79.90	16.12	8.89	1.89	500.25	72.14	0.40	10.11
76.	IC- 335103	47.89	193.04	11.67	87.83	17.18	8.54	2.02	669.30	95.47	0.42	11.75
77.	IC- 335109	45.22	181.35	11.44	88.54	17.26	8.39	2.15	628.61	83.18	0.44	11.09

Sr. No.	Accession No.	Days to 50% silking	Plant height (cm)	No. of leaves/ plant	Leaf blade length (cm)	Sheath length (cm)	Leaf width (cm)	Stem girth (cm)	Green fodder yield/ plant (g)	Dry fodder yield/ plant (g)	Leaf-stem ratio	Crude protein content(%)
78.	IC- 335110	45.11	192.69	12.44	88.04	16.62	8.54	2.11	599.07	84.84	0.53	10.89
79.	IC- 335111	44.33	182.88	12.16	82.67	16.23	9.23	2.01	581.56	77.32	0.42	10.17
80.	IC- 335112	46.11	188.04	11.52	80.83	16.19	7.89	1.97	457.89	73.20	0.39	10.48
81.	IC- 335115	45.22	186.63	11.26	78.23	15.73	8.42	1.91	435.31	85.27	0.36	9.87
82.	IC- 335116	45.56	168.67	12.26	74.61	15.41	7.67	1.91	448.46	76.63	0.43	11.28
83.	IC- 335117	45.78	175.26	11.52	82.83	15.23	8.56	2.03	528.83	89.11	0.40	11.21
84.	IC- 335120	47.22	175.84	11.16	87.66	17.91	8.85	1.98	536.69	78.74	0.47	10.77
85.	IC- 335122	45.00	187.26	11.90	86.42	17.02	7.66	1.82	419.90	81.37	0.40	10.37
86.	IC- 335128	47.78	193.80	12.30	87.39	15.94	9.33	2.16	562.68	99.60	0.42	10.66
87.	IC- 335131	46.11	196.46	12.33	84.90	16.20	8.24	1.96	519.54	95.60	0.55	10.91
88.	IC- 335138	47.33	192.48	11.63	85.38	15.95	7.66	1.97	537.86	99.08	0.38	10.26
89.	IC- 335141	45.56	176.85	10.63	80.86	16.07	7.61	1.94	484.16	84.64	0.33	10.42
90.	IC- 335144	48.00	175.30	10.89	83.07	16.17	8.59	1.84	466.70	66.66	0.52	11.12
91.	IC- 335148	46.56	209.61	11.89	90.24	18.10	8.00	1.93	617.85	105.05	0.37	11.99
92.	IC- 335149	47.44	183.23	10.56	88.11	16.83	8.36	2.01	565.06	97.34	0.34	10.69
93.	IC- 335152	45.00	195.35	11.22	80.33	15.58	8.58	1.83	572.61	109.11	0.30	10.60
94.	IC- 335156	47.33	182.11	11.15	88.04	15.99	8.63	1.85	464.29	79.53	0.46	10.45
95.	IC- 335158	46.11	197.59	11.74	91.42	16.31	8.06	1.98	513.65	95.45	0.39	10.10
96.	IC- 335164	46.11	192.70	11.15	88.54	17.23	8.16	1.86	565.91	98.04	0.30	10.90
97.	IC- 335169	45.44	184.07	10.85	80.69	15.52	7.39	1.81	444.73	77.07	0.38	10.87
98.	IC- 335173	46.00	191.58	10.90	82.85	16.27	7.44	1.79	488.79	83.94	0.31	10.26
99.	IC- 335178	46.33	197.74	12.15	92.53	17.15	8.31	2.18	549.23	91.52	0.37	11.11
100.	IC- 335184	44.67	186.24	10.70	88.39	17.96	8.45	1.98	500.55	94.84	0.35	10.00
101.	African Tall	59.22	268.93	17.44	104.81	20.53	10.21	2.94	1404.17	170.29	0.47	8.66

APPENDIX - III

Mean performance of different accessions for various seed yield characters

Sr. No.	Accession No.	Days to maturity	Ear length (cm)	Ear width (cm)	No. of Kernel rows	Kernels/ row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	100- seed weight (g)	Seed yield/ plant (g)
1.	IC- 334821	79.89	14.72	3.70	13.39	26.19	1.16	0.84	0.81	20.19	175.94
2.	IC- 334825	81.33	15.14	3.48	13.04	30.78	1.37	0.95	0.83	19.89	212.53
3.	IC- 334826	83.44	13.19	3.16	12.63	28.78	1.13	0.82	0.78	18.30	174.14
4.	IC- 334830	88.22	14.93	3.20	11.37	22.87	1.17	0.80	0.83	20.79	157.22
5.	IC- 334833	89.33	13.09	3.24	10.22	25.81	1.01	0.86	0.83	20.07	156.30
6.	IC- 334834	91.11	11.87	3.06	11.30	23.11	1.10	0.82	0.75	16.85	158.95
7.	IC- 334836	86.89	15.61	3.44	11.07	28.44	1.35	0.88	0.91	20.17	220.85
8.	IC- 334837	86.33	12.76	3.30	10.96	25.85	1.10	0.83	0.85	18.86	162.86
9.	IC- 334838	87.89	14.97	3.49	11.26	31.22	1.16	0.92	0.93	22.47	215.12
10.	IC- 334841	78.33	14.65	3.64	12.18	22.11	1.28	0.94	0.86	23.20	172.68
11.	IC- 334842	87.44	16.51	3.73	12.37	27.45	1.35	0.95	0.83	21.54	168.70
12.	IC- 334846	89.44	12.80	3.37	11.26	25.87	1.19	0.96	0.95	21.15	165.46
13.	IC- 334848	82.44	16.34	3.70	14.26	31.70	1.20	0.91	0.80	20.83	214.72
14.	IC- 334853	90.78	14.76	3.70	11.96	26.18	1.27	1.00	0.92	25.56	235.78
15.	IC- 334855	88.78	14.63	3.42	12.00	21.83	1.08	0.88	0.84	22.23	167.75
16.	IC- 334863	89.89	15.76	3.43	12.11	27.63	1.18	0.93	0.86	23.10	161.53
17	IC- 334864	90.56	15.61	3.37	11.15	29.04	1.10	0.89	0.85	21.05	211.11
18.	IC- 334867	90.78	15.61	3.20	10.00	27.83	1.13	0.90	0.91	22.15	170.46
19.	IC- 334869	79.22	17.37	3.63	11.07	33.70	1.39	0.96	0.99	24.72	208.91
20.	IC- 334871	87.67	14.72	3.48	11.67	20.79	1.14	0.87	0.87	23.48	190.97
21.	IC- 334872	88.44	13.67	3.46	12.86	20.61	1.17	0.85	0.75	21.12	131.44
22.	IC- 334876	87.22	13.60	3.42	12.05	24.04	1.22	0.90	0.86	22.20	182.56
23.	IC- 334877	87.44	15.87	3.84	12.00	29.04	1.23	0.90	0.89	21.91	224.51

X

Sr. No.	Accession No.	Days to maturity	Ear length (cm)	Ear width (cm)	No. of Kernel rows	Kernels/ row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	100- seed weight (g)	Seed yield/ plant (g)
24.	IC- 334879	89.67	13.46	3.53	12.52	29.30	1.12	0.90	0.83	19.45	150.50
25.	IC- 334880	86.56	14.37	3.54	11.86	23.67	1.08	0.86	0.88	19.50	135.22
26.	IC- 334881	85.67	12.86	3.32	11.70	24.50	1.16	0.87	0.87	20.34	165.34
27.	IC- 334884	86.89	13.50	3.54	11.96	22.67	1.12	0.90	0.87	22.69	142.96
28.	IC- 334889	82.78	13.48	3.09	10.25	24.18	1.06	0.82	0.82	20.27	151.14
29.	IC- 334904	94.11	12.03	3.54	13.18	19.59	1.06	0.81	0.82	19.83	126.21
30.	IC- 334915	82.78	14.54	3.37	11.48	29.89	1.30	0.86	0.83	21.14	168.53
31.	IC- 334920	90.44	13.74	3.18	12.52	26.67	1.11	0.84	0.79	19.44	147.53
32.	IC- 334929	79.33	16.69	3.40	12.78	27.70	1.18	0.94	0.83	22.19	197.84
33.	IC- 334932	80.11	16.74	3.90	13.37	28.11	1.31	1.00	0.94	24.58	208.97
34.	IC- 334942	91.44	16.94	3.63	14.31	28.26	1.20	0.94	0.81	22.49	130.20
35.	IC- 334943	91.89	14.87	3.57	11.41	25.96	1.09	0.98	0.90	21.80	143.72
36.	IC- 334944	90.33	15.04	3.76	14.74	29.56	1.21	0.92	0.80	19.92	182.77
37.	IC- 334945	93.78	14.37	3.46	12.89	25.93	1.13	0.90	0.76	19.21	167.47
38.	IC- 334947	76.67	13.53	3.62	14.48	28.44	0.98	0.85	0.78	18.85	175.11
39.	IC- 334949	88.22	16.10	3.60	12.53	28.07	1.18	0.86	0.79	20.24	154.67
40.	IC- 334954	91.11	13.83	3.39	12.47	20.37	1.11	1.02	0.93	24.44	172.03
41.	IC- 334955	74.67	15.75	3.33	11.96	29.70	1.29	0.89	0.82	20.63	162.17
42.	IC- 334957	86.22	15.65	3.35	11.78	25.56	1.19	0.88	0.86	21.82	196.00
43.	IC- 334973	72.67	14.90	3.59	13.30	30.15	1.28	0.87	0.81	20.36	174.57
44.	IC- 334974	73.44	14.57	3.57	12.33	30.28	1.47	0.93	0.87	20.80	245.44
45.	IC- 334989	74.22	16.19	3.43	12.93	29.81	1.27	0.77	0.75	17.73	159.23
46.	IC- 334996	79.67	19.44	3.69	12.13	37.15	1.59	0.84	0.86	21.25	167.00
47.	IC- 334999	79.67	17.76	3.77	12.15	37.07	1.30	0.92	0.85	19.92	237.66
48.	IC- 335000	76.33	16.76	3.63	12.46	33.19	1.31	0.86	0.83	20.79	210.93
49.	IC- 335009	83.22	17.81	3.74	13.48	29.63	1.35	0.88	0.84	21.37	213.94
50.	IC- 335017	78.67	15.52	3.65	12.52	32.26	1.39	0.95	0.85	20.72	194.97
51.	IC- 335024	80.22	19.81	3.79	12.53	30.96	1.53	0.89	0.88	24.57	260.64

Sr. No.	Accession No.	Days to maturity	Ear length (cm)	Ear width (cm)	No. of Kernel rows	Kernels/ row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	100- seed weight (g)	Seed yield/ plant (g)
52.	IC- 335025	77.33	16.93	3.50	12.55	31.63	1.48	0.83	0.79	21.27	172.90
53.	IC- 335027	84.00	15.55	3.79	13.26	37.83	1.24	0.90	0.86	19.13	218.05
54.	IC- 335028	76.78	16.91	3.31	12.30	33.63	1.22	0.86	0.78	18.30	194.72
55.	IC- 335032	80.00	17.34	3.80	12.91	36.33	1.34	0.91	0.86	20.92	214.19
56.	IC- 335035	86.00	17.41	3.59	13.17	38.39	1.23	0.90	0.79	20.55	198.52
57.	IC- 335041	82.11	15.55	3.61	13.59	31.44	1.30	0.92	0.84	21.06	210.22
58.	IC- 335043	73.78	17.32	3.55	12.15	36.89	1.43	0.91	0.87	19.61	213.30
59.	IC- 335045	75.00	17.94	3.46	12.36	27.15	1.42	0.88	0.89	18.53	149.04
60.	IC- 335048	81.67	17.11	3.69	11.85	28.55	1.41	0.83	0.86	20.59	211.37
61.	IC- 335050	79.00	17.80	3.60	13.65	35.33	1.30	0.84	0.85	18.79	180.24
62.	IC- 335051	78.56	14.81	3.52	11.85	26.44	1.30	0.85	0.87	20.53	184.59
63.	IC- 335053	76.33	16.92	3.38	12.30	35.07	1.41	0.81	0.79	19.19	190.27
64.	IC- 335056	72.22	14.50	3.37	12.11	30.22	1.20	0.75	0.79	18.43	168.05
65.	IC- 335060	73.33	13.14	3.46	14.09	25.74	1.26	0.79	0.74	16.77	151.78
66.	IC- 335062	73.11	13.26	3.24	13.24	28.41	1.22	0.75	0.75	15.71	152.03
67.	IC- 335068	72.67	12.38	3.56	13.74	27.59	1.18	0.87	0.81	17.41	178.57
68.	IC- 335069	70.33	15.05	3.41	12.96	28.48	1.13	0.82	0.81	15.97	172.03
69.	IC- 335079	75.67	14.61	3.49	13.81	32.20	1.17	0.82	0.79	17.02	163.14
70.	IC- 335082	76.78	16.97	3.67	12.98	36.07	1.26	0.78	0.86	17.74	212.61
71.	IC- 335086	72.78	15.39	3.36	12.70	32.07	1.21	0.75	0.74	14.53	155.37
72.	IC- 335089	75.00	15.22	3.43	12.20	29.56	1.19	0.83	0.83	18.07	168.51
73.	IC- 335092	77.56	17.09	3.45	11.81	33.81	1.30	0.83	0.91	21.46	190.04
74.	IC- 335094	76.33	17.52	3.61	11.65	40.42	1.27	0.85	0.90	21.47	245.48
75.	IC- 335098	73.56	17.20	3.33	11.87	36.59	1.26	0.82	0.84	18.00	182.32
76.	IC- 335103	81.78	17.59	3.30	11.72	30.01	1.31	0.82	0.87	18.83	185.96
77.	IC- 335109	77.33	17.02	3.37	12.15	38.37	1.26	0.81	0.81	18.81	171.96
78.	IC- 335110	78.22	18.37	3.13	12.32	37.22	1.26	0.82	0.78	16.35	179.96
79.	IC- 335111	70.00	16.58	3.53	12.89	37.29	1.23	0.84	0.79	16.73	175.04

Sr. No.	Accession No.	Days to maturity	Ear length (cm)	Ear width (cm)	No. of Kernel rows	Kernels/ row	Shank diameter (cm)	Kernel length (cm)	Kernel width (cm)	100- seed weight (g)	Seed yield/ plant (g)
80.	IC- 335112	79.44	17.46	3.38	11.85	35.52	1.29	0.82	0.84	18.85	207.51
81.	IC- 335115	84.11	17.14	3.18	11.81	36.43	1.04	0.82	0.75	15.54	154.47
82.	IC- 335116	75.44	15.15	3.60	12.70	34.22	1.49	0.89	0.83	22.39	248.51
83.	IC- 335117	75.44	18.21	3.51	12.33	39.00	1.27	0.85	0.83	19.86	214.42
84.	IC- 335120	76.67	17.59	3.40	11.71	40.30	1.27	0.85	0.85	18.31	213.17
85.	IC- 335122	73.67	16.47	3.40	11.96	34.48	1.30	0.87	0.84	19.87	238.27
86.	IC- 335128	77.44	16.22	3.55	12.32	33.11	1.27	0.80	0.84	17.75	174.97
87.	IC- 335131	76.11	16.98	3.45	11.46	36.96	1.43	0.80	0.84	20.12	173.56
88.	IC- 335138	78.44	14.58	3.23	11.68	34.00	1.14	0.86	0.79	17.78	179.55
89.	IC- 335141	77.78	16.24	3.29	10.97	27.85	1.30	0.83	0.84	18.22	137.85
90.	IC- 335144	83.33	16.06	3.52	13.17	32.44	1.36	0.89	0.78	18.03	157.19
91.	IC- 335148	81.33	17.02	3.40	11.59	36.74	1.29	0.89	0.92	20.85	226.82
92.	IC- 335149	76.11	15.58	3.08	11.74	33.37	1.23	0.82	0.79	17.19	169.70
93.	IC- 335152	79.89	15.35	3.68	12.96	32.68	1.39	0.93	0.86	18.18	193.22
94.	IC- 335156	86.67	16.39	3.48	12.19	30.63	1.40	0.76	0.75	18.20	223.15
95.	IC- 335158	77.00	17.80	3.46	14.26	39.26	1.20	0.82	0.74	16.11	191.27
96.	IC- 335164	75.56	16.15	3.34	12.29	32.70	1.26	0.82	0.80	18.68	167.49
97.	IC- 335169	75.78	15.30	3.27	11.85	34.57	1.24	0.88	0.80	18.21	182.87
98.	IC- 335173	80.78	16.20	3.33	12.44	35.63	1.31	0.91	0.87	17.61	201.72
99.	IC- 335178	79.33	16.45	3.48	12.73	35.85	1.20	0.81	0.81	17.76	167.56
100.	IC- 335184	74.11	16.48	3.40	12.04	32.89	1.30	0.80	0.81	18.14	176.89
101.	African Tall	119.33	21.34	3.71	13.17	39.26	1.62	0.94	0.90	25.73	261.61

Abbreviation

Cob	:	Ear
Test weight	:	100 seed weight
Kernel	:	Seed
CP	:	Crude protein
ml	:	Milliliter
mg	:	Milligram
µl	:	Microliter
ANOVA	:	Analysis of variance
df	:	Degree of freedom
ss	:	Sum of square
ms	:	Mean sum of square